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THE EARLY EMBRYOLOGICAL DEVELOPMENT OF MELOPHAGUS OVINUS L., WITH SPECIAL REFERENCE TO THE DEVELOPMENT OF THE GERM CELLS

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The embryology of *Melophagus ovinus* was first studied by Leuckart (1858), who gave some excellent figures of the entire egg. He observed some of the early stages in the development of the egg such as the presence of sperms within the fertilized egg. These have been overlooked or fully ignored by his successors. Pratt in 1901, working with the same insect, also gave a description of the egg, though the earliest stage observed by him was already well along in its cleavages. Hardenberg (1929) presents a comparative study of the embryology of the entire family Pupipara. Stange (1907) in the only other developmental study on *Melophagus ovinus*, restricted his study to the development of imaginal discs of wings and halteres in the larva. The chief object in this investigation was to study the early development in the egg

and to trace out the germ cells to their final destination, these constituting the two main points which remained unexplored in the earlier investigations upon *Melophagus ovinus*, and to a certain degree correcting misconceptions held by my predecessors.

MATERIAL AND TECHNIQUE

During the course of the investigation about 300 uteri containing embryos were sectioned and stained. Zenker's fixative was found to be the most satisfactory, while the staining with iron-alum haematoxylin and destaining with picric acid yielded the best results. Delafield's and Ehrlich's haematoxylin was also used. Orange G. was used as a counterstain. Sections of 3 and 4 microns in thickness were found to facilitate the tracing of the germ cells. All drawings were made with the aid of the camera lucida.

PRODUCTION OF EGGS AND CONDITION OF MATURE OVUM

Several young female ticks were dissected and their genital tracts sectioned. It was found that these young females had already been fertilized, the sperms being stored in the atrium. When the egg is developing in the ovary the nucleus can be seen to be situated close to the anterior end (pointing in a posterior direction of the female tick), where the large nucleated nurse cells are located. There are a few scattered granules and a varying number of nucleoli present in the nucleus of the egg, but chromatin material could not be shown with the stains used. As the egg becomes fully matured, the nucleus will be found migrating further toward the middle of the egg on the dorsal side. When the egg is ready to be passed out through the atrium into the uterus, the nucleus will be in the metaphase stage of the first polar spindle. The chromosomes on this spindle stain very heavily with haematoxylin, so that a count of their number is impossible (Plate I, 1). Huettner (1924) shows that the same condition prevails in *Drosophila*, and previous investigators have reported the same for a great variety of insects. Normally the females of Pupipara with the exception of *Braula* will mature one egg at a time. Among my material were two uteri each containing two eggs, both with complete egg envelopes and micropyles. The right and left ovaries of one of these were in about the same stage of development, so that I can assume that this twinning condition would again have arisen, had the female been allowed to remain alive (Plate III, 32 and 34). My search for twins in the larval condition was fruitless, and so my assumption is that one of the larvae is aborted as soon as it emerges from the egg, or that it succumbs due to the lack of nourishment which of course will be taken up by the larva nearest to the milk gland orifice.

DESCRIPTION OF THE EGG

Measurements of an egg picked at random show a total length of 1.161 mm. (disregarding the micropyle and the egg envelopes which have shrunken away from the egg) and 0.3 mm. in width, figures which coincide quite well with those given by Leuckart and Pratt.

In all the eggs of my series, from the earliest to the latest stage, I have found present two definite membranes of equal thickness surrounding the egg, which I interpret as being the chorion and vitelline membrane (Plate II, 18 and others). Huettner (1923) in describing the egg of *Drosophila* mentions that the egg possesses a plasma membrane in addition to the two distinct membranes, the chorion and the vitelline membrane, which surround the egg. In the egg of *Melophagus ovinus* no definite plasma membrane can be made out in the early stages, but its presence must be assumed for reasons stated later under the description of the germ cells and blastoderm formation. My findings therefore are in accordance with the conditions prevailing in most Diptera, and differ from the observations of Pratt and Hardenberg in their interpretation, Pratt claiming the presence of a two-layered chorion, the outer one much thicker than the inner one, and a delicate vitelline membrane, while Hardenberg states that there is present around the egg but one envelope and that the first larval skin is formed during the blastoderm stage. I must conclude from Hardenberg's statements that he lacked most of the early stages and therefore had insufficient evidence to support his conclusions.

The yolk granules are held in place by a reticulum of protoplasm. There is a very thin layer of protoplasm, the periplasm, in the periphery of the egg, which broadens out considerably in the anterior and posterior poles of the egg. The protoplasm of the anterior pole does not seem to contain any peculiar constituents, but the posterior periplasm contains the germ-line determinant or germ plasm (polar granules, "Keimbahnplasma," "Blochmann's bodies") which is visible in properly stained slides. Hardenberg saw it in later stages of eggs in all Pupipara. The germ plasm is a plate of granular bodies which is almost uniform in shape (Plate II, 14). It is most evident in slides stained with iron-alum haematoxylin.

FERTILIZATION AND MATURATION

The only account of the early development of the eggs of *Melophagus ovinus* is given by Leuckart whose observations, so far as they go, I can substantiate. I was fortunate enough to obtain several eggs showing the main features of maturation divisions of the oocyte nucleus and the presence of sperms within the egg.

Contrary to all statements about the position of maturation spindles in Diptera as occurring in the anterior third of the egg, I found this situated below the middle, on the dorsal side of the egg, and since the resulting polar bodies do not change their relative position in the egg, I could verify my findings by checking the position of these in the eggs.

The earliest stage obtained after the egg had entered the uterus and the earliest in which sperms were observed possessed only one maturation spindle, which I take to be the first maturation spindle. The spindle is still in the metaphase stage in which it had reached the uterus, but now the chromosomes have moved apart slightly, so that their number can be counted. The spindle is surrounded by a little protuberance of the periplasm. The haploid number of chromosomes of the oocyte was found to be eight, the tetrad nature of the chromosomes being apparent

in two of them. The two parts of the spindle are represented in Plate I, 2a, b.

This egg also contained six sperms, each head being separated from its tail, but lying very close to it (Plate I, 3 and 4). At this stage the head of the sperm had swollen and become vacuolated. Sperm asters and arrhenoid could not be made out. The tail of the sperm in each case stains very heavily and is represented by a coiled and twisted mass, usually lying anterior and close to the head. In the atrium only the head of the sperms stain with haematoxylin, the tails are left colorless. Huettner (1924) made similar observations for *Drosophila*.

In *Melophagus* all the sperms seem to have congregated in the middle and posterior half of the egg near the oocyte nucleus; no sperms were found in the periplasm or floating underneath the vitelline membrane, as Leuckart had reported.

The next stage in maturation is shown in Plate I, 6. Here the first polar body has been thrown off, another spindle and the second polar body spindle have been formed. They are both in the same stage of development, with eight double chromosomes in each spindle. Four sperms were found in this egg. Their tails still stain brightly, their heads are vacuolated, having about the same appearance as the one figured for the egg in the earlier stage of development. No structure such as Henking (1892) described as the thelyid was seen.

Six sperm heads were counted in an egg slightly older than the previous ones, and in each the vacuolated nature is much more evident, but the tails have practically disappeared, their position being represented by a cloudy area (Plate I, 5). The actual union of male and female pronuclei was not observed. I assume, however, that it occurs in a similar fashion to that described by Huettner for *Drosophila*, since the development preceding this union is similar in most respects in both insects. Hardenberg's statement of the occurrence of monospermy in *Melophagus* can be discarded as wrong since he never observed any of the stages under consideration, so that we can say polyspermy is the rule in *Melophagus*, and that a monospermic condition either never occurs or is very rare. By the time of the formation of two cleavage spindles there is no trace left whatsoever of supernumerary sperms, such as is the case in *Drosophila*, where supernumerary sperms remain visible till thirty cleavage nuclei are formed.

Hallez law of the orientation of the embryo in the egg was proved to hold in this case. No observations on the time or place at which the sperms penetrate the egg were made, so that Leuckart's assumptions on these points still remain to be verified.

CLEAVAGES AND FURTHER DEVELOPMENT OF THE POLAR BODIES

The polar bodies which were thrown off during the maturation divisions form three distinct masses of chromosomes which lie on the dorsal side of the egg. This condition was found present in an egg containing two cleavage spindles in the metaphase stage. The polar bodies are drawn from consecutive sections (Plate I, 7 and 8). Each group contains eight chromosomes and the periplasm at this point is thicker than usual.

The next step in the development was noted in an egg containing five cleavage spindles in which the nuclear wall is formed around the polar bodies, the chromosomes forming a solid mass (Plate I, 9). There seems to be some irregularity about the formation of the polar bodies, since one egg containing five cleavage nuclei only showed two polar bodies, one of which measured 6.6 microns, while the larger one of the two measured 12.37 microns (Plate I, 10). In this case the first polar body may have failed to divide, or if it did divide two chromosome groups may have been included within one nuclear wall. The chromosomes in these polar bodies have lost their distinctness, and the chromatin material is now distributed over the reticulum.

Another egg having eighteen cleavage nuclei mostly in spindle form shows the three polar bodies, which do not have the rounded appearance of those described in the previous preparation, but have assumed a rather irregular shape. From this time on they seem to stay in this condition until final disintegration (Plate I, 11). A stage corresponding to the earlier one is shown in Plate I, 12, the egg containing fifty-six cleavage nuclei. The latest stage in which the polar bodies were recognizable as such was in an egg with one hundred and twelve cleavage nuclei, where there is part of a nuclear wall left around only one of the bodies (Plate I, 13). In later stages the cleavage nuclei have reached the periphery of the egg, and no trace can be found of the polar bodies.

The progressive development of the polar body formation may not always occur as I have outlined above but may be retarded in some instances; however, they eventually will probably go through the same processes and finally disintegrate.

Hardenberg has already pointed out that cleavage divisions do not occur synchronously. When the cleavage nuclei migrate to the periphery they leave behind a trail of protoplasm. A mitosis spindle from an egg containing seventy-five cleavage nuclei is shown in Plate III, 35. The two centrosomes are clearly visible, as is a distinct aster. The chromosomes in these spindles are very slender and quite small. Overlapping and their beaded appearance make counts very uncertain. A count made in a later stage embryo (Plate III, 37) indicates that there are sixteen chromosomes in the somatic cell. An egg possessing some anomaly in its mitotic behavior came to my attention. A spindle showing the chromosome fragments on the spindle while the rest of the chromosomes have reached the opposing poles is shown in Plate III, 36.

GERM CELLS

The main purpose of this study was to determine the possibility of tracing the germ cells from their origin to their final destination in the gonad. Other investigators of embryology of the Diptera have traced these cells from the time of their penetration of the germ plasm to their entrance into the posterior rudiment. Escherich (1900) saw these cells within the posterior rudiment in the Muscid embryo. Noack, the following year, working with the same group, traced these cells but also lost track of them in the final stages, so that he only assumed that the pole cells give rise to germ cells. I was fortunate enough to obtain a complete series of *Melophagus* embryos in which the germ cells could

be traced to their final destination into the larval gonad which persists throughout the larval period and gives rise to the ovary or testis in the adult insect.

Leuckart and Pratt do not describe the germ cells in *Melophagus*, while Hardenberg who saw the germ plasm in the eggs of all the Pupipara he examined gives a different interpretation. He includes a schematic longitudinal section of an egg of *Lipoptena cervi* which is strikingly similar to my Figure 19 on Plate II. For *Melophagus* he contends that the germ cells are as hard to differentiate as they are in *Lucilia*, and therefore does not discuss the fate of the germ cells since they are practically indistinguishable from blastoderm nuclei in the later stages. I found on the contrary that throughout the embryonic development the germ cells can always be recognized by their granular appearance.

(*a*) *Origin*

The migrating cleavage nuclei reach the dorsal and ventral sides of the egg first, the anterior and posterior poles being invaded later. As soon as the nuclei reach the anterior and posterior periphery of the egg, we have a condition present at the posterior end of the egg as represented in Figure 15 on Plate II. Nuclei invade the germ plasm, each one accumulating granules of the plate around it and then rise above the general surface level of the periplasm. The germ plasm assumes a crescentic form (Plate II, 16) seemingly propelled along by the nucleus. The nuclei thus penetrating the germ plasm are the primordial germ cells and are twelve in number. As in the case of *Drosophila* evidence points toward the fact that all the nuclei (12 in *Melophagus*) will have invaded the posterior pole of the egg simultaneously and do not arise from one or two original germ cells. These cells will continue with their mitotic divisions, so that a later stage will contain twenty-four nuclei after which their number increases very rapidly. Figure 15 on Plate II represents the posterior part of such an egg containing twenty-four germ cells, three being cut in the particular section. The nuclei in the remainder of the periphery of the egg will give rise to the blastoderm as described by Pratt. The nuclei forming the blastoderm will also push the periplasm out beyond the original surface level of the periplasm. Between each nucleus there appears a little condensation of protoplasmic material which I take to be the broken and shrunken plasmic membrane, which is thus made visible. It may be the membrane which later forms the separation between the germ cell mass and the posterior proliferation. In the blastoderm it may give rise to the basement membrane (Plate II, 16).

At the posterior end then arises what Hardenberg has called the caudal or posterior proliferation. At the anterior end the cephalic or anterior proliferation has not yet made its appearance. The first nuclei in the posterior proliferation appear to have arisen from divisions of the germ cells (Plate II, 16). Huettner (1923) found germ cells dividing giving rise to other germ cells or if one portion was not surrounded by germ plasm it gave rise to ordinary blastoderm cells. In *Melophagus* those cells with apparently insufficient amount of germ plasm wander out of the region of the germ cell mass which is accumulating at the posterior end of the egg.

The anterior proliferation arises from nuclei which have invaded the periphery in a circle around the base of the micropylar funnel. The nuclei in dividing may be seen following a stream of protoplasm which extends conically into the interior of the egg. Secondary yolk cells will arise from nuclei that are pushed in from the general level of the blastoderm (Plate II, 18). Primary yolk cells have arisen during the migration stages of the cleavage nuclei toward the periphery.

(*b*) *In the Blastoderm Stage*

Nuclei forming the anterior and posterior proliferations, after the cell walls are formed in the blastoderm, probably come from the blastoderm cells which abut directly upon the mass of germ cells at the posterior end of the egg, and from a ring of blastoderm cells around the micropylar funnel at the anterior end of the egg. A membranous partition is formed which cuts the germ cell mass off from the posterior proliferation. This partition only shows up well in slides stained with iron-alum haematoxylin. This stage is shown in Figure 19 on Plate II, the germ cell mass in this egg containing from 230 to 250 nuclei. This is the figure in the development of *Melophagus* which so strikingly resembles Hardenberg's Figure 10 of *Lipoptena cervi*, which however lacks the separating membrane between an extensive mass of germ cells and the posterior proliferation. The tertiary yolk cells arise from nuclei which wander into the yolk from either the anterior or posterior proliferations. The primary and secondary yolk nuclei have a rather pyknotic appearance.

(*c*) *In the Germ Band Stage*

The blastoderm almost completely encloses the yolk, except at the two places where the anterior and posterior proliferations have arisen. The first sign of the origin of the germ band is the development of the head fold which is the first to arise, and a thinning out of the dorsal portion of the blastoderm where it comes in contact with the head fold. The ventral part of the blastoderm then thickens, abruptly interrupted at its junction with the germ cell mass. The germ band is slightly transversely corrugated into folds which later are smoothed out again (Plate II, 20). This is followed by the closure of the circular areas left in it by the formation of the anterior and posterior proliferations. It is from one of these actively dividing cells at the anterior end that Figure 37 on Plate III was taken, which shows the sixteen chromosomes on the equatorial disc.

There is no regular tail-fold formed such as the other Muscids produce, the germ band covering the posterior pole just reaching the dorsum. The germ cells in this stage are still seen to form the cap over the posterior pole of the egg. Sometime between the formation of the blastoderm and the formation of the germ band the germ cell mass will have acquired its maximum number of nuclei and from now on we will find their number gradually decreasing. Whatever may be the cause, nuclei unaccompanied by sufficient quantity of germ plasm are unable to develop into germ cells. The head-fold is now arrested in its growth and the most radical changes are encountered in the posterior end of the egg only.

The next step in the development of the embryo is the formation of the lower layer or mesoderm (Plate III, 31). The anterior and posterior proliferations which have not completely disappeared now form two strands of tissue which can be recognized as the anterior and posterior enteron rudiments (Plate II, 21, 22, and 23).

Since no serosa is formed in the Muscids and an amnion is rudimentary this condition may be expected to be present in *Melophagus*. We find however that in *Melophagus* this retrogressive development has progressed still further. No serosa is present, the dorsal blastoderm persisting till a very late stage in the development of the embryo, and being replaced very rapidly by adjoining ectoderm in a stage not figured but occurring between Figures 28 and 33. No true amnion can be recognized in *Melophagus*, since there is no true tail-fold developed till later, which remains uncovered, so that the cavity which appears at the posterior end must be the amniotic cavity and at the same time the proctodaeum, since it is from this cavity that the Malpighian tubules arise. I will therefore designate this cavity as the amnio-proctodaeal cavity.

(*d*) *Within the Amnio-proctodaeal Cavity*

Returning to the development at the posterior end of the egg, the germ band here seems to push ahead gradually on the dorsal side, so that the germ cells which lie in close contact with the ectoderm are pushed along toward the dorsal side of the egg (Plate II, 21). At the point where the germ cells are located a plate will be found arising in the ectoderm which soon caves in, so that the germ cells come to lie in a very shallow depression of the ectoderm. This is the amnio-proctodaeal cavity. The germ band stage with the mesoderm already formed is shown in a sagittal section of an egg in Figure 21. The next stage with the slight depression representing the origin of the amnio-proctodaeal cavity is shown in Figure 22. This depression increases rapidly in depth, the germ band pushing farther over the posterior pole of the egg, thus forming a tail-fold (Plate II, 23).

(*e*) *Migration through the Amnio-proctodaeal Wall*

As soon as the amnio-proctodaeal cavity has lengthened sufficiently the germ cells which lie within start on their migration into the interior of the embryo (Plate II, 24). How the passage into the interior is accomplished was not determined. The wall of the amnio-proctodaeal cavity shows no definite canal through which all the germ cells migrate, such as Escherich (1900) described for *Musca*. The cells seemingly push their way into the wall wherever they happen to be located. The number of germ cells had already diminished considerably in an earlier stage; furthermore some cells are left behind in this cavity which do not correspond exactly with the germ cells in appearance, and some which were never included within the forming cavity. It is thus seen that the number of germ cells is again diminished as development progresses (Plate II, 24 and 25).

(*f*) *Migration on the Enteron Rudiment*

A little later germ cells may be found in the amnio-proctodaeal cavity, others in and on the posterior rudiment and some which are not included in this cavity at all (Plate II, 25). By this time the posterior

rudiment has started to proliferate, growing foreward on the dorsal side of the yolk as well as growing ventrally to surround the yolk, but leaving as yet the entire ventral portion of the yolk uncovered. The Malpighian tubules arise as invaginations from the proctodaeum. Germ cells with or without sufficient germ plasm and which failed to penetrate through the amnio-proctodaeal wall are found within these invaginations, but they finally disappear. Apparently at one period only are the germ cells able to migrate through the wall, those which fail to do so disintegrate. The germ cells move along on the enteron rudiment in advance of the developing Malpighian tubules.

While the anterior and posterior rudiments are proliferating the head fold resumes its activity. From a plate similar to that described at the posterior end the stomodaeal invagination will appear, which in these stages will be found on the dorsal side of the embryo, not migrating to the anterior end of the embryo until much later. When the stomodaeum has made its appearance the anterior and posterior rudiments will have grown sufficiently to meet on the dorsal side. A cross-section through the posterior end of such a stage is shown in Figure 27. This section of which an enlarged portion is given in Figure 26, shows a large number of germ cells lying on the dorsal side of the enteron rudiment, with another group of them on one side on the surface of the entoderm. In the interior of the rudiment a few cells having the same appearance as germ cells may be seen. The latter may be the cells without the sufficient amount of germ plasm which were included in the posterior proliferation in the early stages, but I doubt whether they are ever included within the gonad.

In a later stage which is represented in a sagittal section in Figures 28 and 29 on Plate III, the germ cells are associated with other cells, which presumably are mesodermal cells, representing the beginning of the development of the gonad. A few scattered germ cells which lie free on the enteron rudiment may later disintegrate. At this stage the stomodaeum begins to move up toward the anterior end, though it is still dorsal in position. The dorsal body wall not yet having developed, the dorsal blastoderm still covers the dorsal surface of the embryo.

(g) *Final Location of Germ Cells*

When the stomodaeum has reached its definitive position at the anterior end of the embryo (Plate III, 34) the formation of the dorsal body wall has just begun. The gonad in this case has attained a considerable size, being made up of cells whose arrangement is very characteristic. In the earlier stages one can still find that the cytoplasm of the primordial germ cells has the characteristic granular appearance (Plate III, 30).

The splitting of the mesoderm into splanchnic and somatic layers occurs during this development but is not very pronounced until the final stages of the embryonic development are reached such as represented in Figure 33. The first indications of tracheation are seen at about the time of the growth of the entoderm which is beginning to enclose the yolk, as shown in Figure 27. After the stomodaeum has moved to its definitive position the muscular tongue is developed within it and the imaginal discs may be seen located on the ventral side of the embryo. A study of the development of the nervous and muscular

system reveals nothing especially new. The gonads in the later stages resemble each other in appearance, no further development taking place in the embryo.

SUMMARY

The egg of *Melophagus ovinus* enters the uterus at the time of the formation of the first polar body, and is penetrated by from four to six sperms. Maturation occurs in the usual manner. The haploid chromosome number of the oocyte is eight; the somatic chromosome number, sixteen. Two polar bodies are formed, of which the first one ordinarily undergoes another division, but occasionally does not do so. The maturation divisions occur in the posterior third of the egg. Supernumerary sperms disappear soon after the union of the male and female pronuclei. The polar bodies were found to disintegrate in an egg by the time one hundred and twelve nuclei had formed.

When the cleavage nuclei reach the periphery of the egg twelve nuclei penetrate the germ plasm plate forming the primordial germ cells. They undergo many divisions and form a mass of pole cells at the posterior end of the egg during the blastoderm and germ band stages. They are then included within the amnio-proctodaeal invagination and travel through its wall coming to rest on the posterior enteron rudiment. The posterior enteron rudiment grows anteriorly and around the yolk and it thus brings the germ cells to their final position. Here they associate themselves with mesodermal cells with the formation of the gonad.

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ABBREVIATIONS USED IN PLATES

ant. pro.—anterior proliferation
ant. rud.—anterior enteron rudiment
atr.—atrium
bl.—blastoderm
bl. n.—blastoderm nucleus
br.—brain.
ch.—chorion
cl. n.—cleavage nucleus
d. bl.—dorsal blastoderm
d. trach.—dorsal trachea
ect.—ectoderm
ent.—entoderm
ent. n.—entoderm nucleus
g.—gonad
g. b.—germ band
g. c.—germ cell
g. cs.—germ cells
g. l. d.—germ line determinant or germ plasm
h. f.—head fold
mes.—mesoderm
mi.—micropyle
m. t.—Malpighian tubule
p. p.—protoplasmic path
post. pro.—posterior proliferation
post. rud.—posterior enteron rudiment
proc.—amnio-proctodaeal cavity
stom.—stomodaeum
suboes. g.—suboesophageal ganglion
trach.—trachea
vent. g.—ventral ganglia
vit.—vitellophage
vit. m.—vitelline membrane
y.—yolk

EXPLANATION OF FIGURES

In each case the thickness of the section as well as the stain used and the magnification is indicated. The following abbreviations are used: Fe. H.—Iron Haematoxylin; O. G.—Orange G.; E. H.—Ehrlich's Haematoxylin; D. H.—Delafield's Haematoxylin.

Plate I

1. A portion of ovarian egg showing the 1st maturation spindle in metaphase. 3μ; Fe. H.; 588×.
2, a, b. Two consecutive sections showing 1st maturation spindle in a fertilized egg. The chromosome tetrad can be recognized in Figure b. 6 chromosomes on spindle in Figure a, two in b. 4μ; Fe. H. and O. G.; 588×.
3. Entire egg, showing 3 sperm heads and one tail, and a fourth protoplasmic island of another sperm. The cross indicates the position of the first maturation spindle shown in the previous figure. 4μ, Fe. H. and O. G.; 34×.
4. Sperm head and tail greatly magnified drawn from a section of the same egg as shown in the two previous figures. Head vacuolated. 4μ; Fe. H. and O. G.; 588×.
5. Sperm head and tail from an egg in which maturation is completed. Vacuolated structure of sperm head still more prominent. 4μ; Fe. H. and O. G.; 588×.
6. Portion of egg showing 1st polar body spindle and the female pronucleus in the process of throwing off the 2nd. polar body; 8 double chromosomes in each spindle. 3μ; Fe. H. 588×.
7 and 8. Two consecutive sections of an egg containing two cleavage spindles, showing three masses of 8 chromosomes each, representing the polar bodies. 3μ; Fe. H.; 588×.
9. Polar bodies from an egg with five cleavage nuclei. 3μ; Fe. H.; 588×.
10. Polar bodies from an egg with 6 cleavage nuclei. 3μ; Fe. H.; 588×.
11. Polar bodies from an egg with 18 cleavage nuclei. 3μ; Fe. H.; 588×.
12. Polar bodies from an egg with 57 cleavage nuclei. 3μ; Fe. H.; 588×.
13. Polar bodies from an egg with 112 cleavage nuclei. 4μ; Fe. H.; 588×.

Plate II

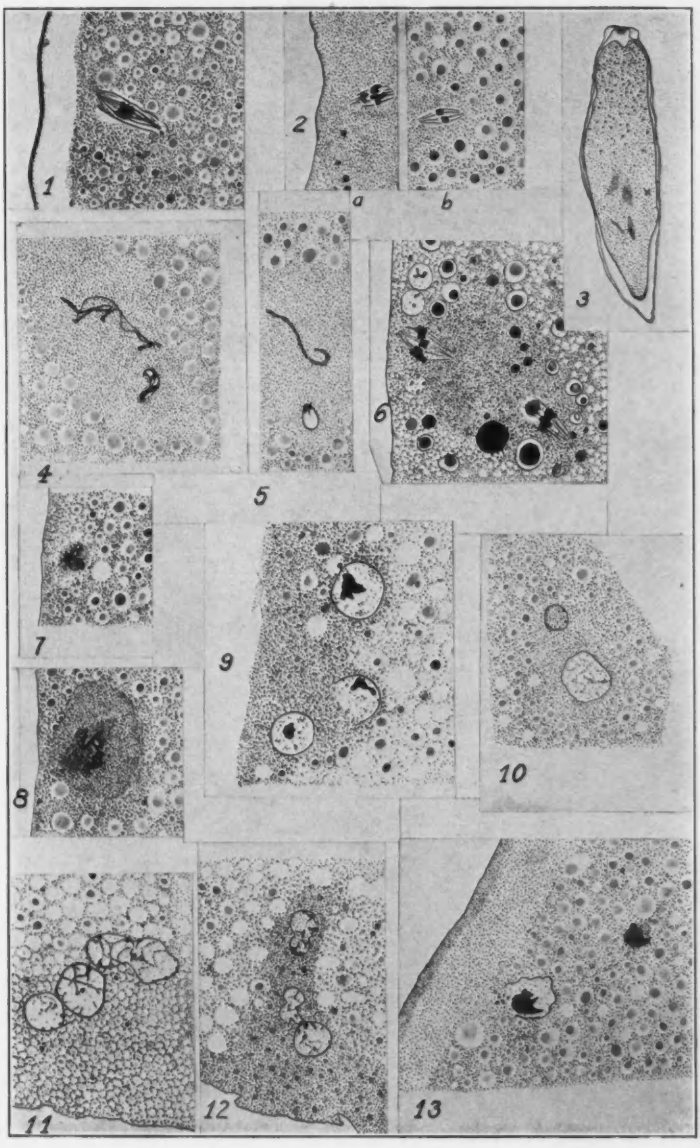
14. Section of entire egg showing 4 cleavage nuclei all in one plane. The germ plasm plate is at the posterior end of the egg. 4μ; Fe. H. and O. G. 34×.
15. Posterior end of egg showing the germ cells (24 in this entire egg) penetrating the germ plasm plate, leaving a distinct protoplasmic path behind in the yolk. The blastoderm nuclei have reached the periphery. 3μ; Fe. H. 140×.
16. Posterior end of a more advanced stage, showing the germ cells and blastoderm cells. There are about 100 germ cells formed in this egg, and the posterior proliferation has started. 3μ; Fe. H. and O. G. 140×.
17. More advanced stage of egg, in which the cell walls of the blastoderm are arising. A few germ cells are shown on the outside. This is not a mid-

sagittal section, so it does not show the break in the blastoderm. 3μ; E. H.; 588×.

18. Anterior end of egg in which the blastoderm is formed. The micropyle, chorion, vitelline membrane and the anterior proliferation are shown. 3μ; Fe. H. and O. G. 140×.
19. Posterior end of egg shown in the previous figure, showing the germ cell mass, which is divided from the posterior proliferation by a delicate membrane. The entire germ cell mass in this egg contained about 250 nuclei. 3μ; Fe. H. and O. G. 140×.
20. Composite drawing of a section of an entire egg, showing the origin of the germ band. Anterior and posterior proliferations and germ cell mass are shown. The anterior end is drawn slightly off center, so that the anterior interruption in the blastoderm is not visible, while the posterior end is drawn from a midsagittal section through that portion. 4μ; Fe. H. 34×.
21. Section of entire egg, showing the germ band with the mesoderm and entoderm. The germ cells have decreased in number. 3μ; D. H. and O. G. 34×.
22. Posterior end of egg of a more advanced embryo, showing the formation of the amnio-proctodaeal cavity, on which the germ cells are located. 3μ; Fe. H. 64×.
23. Entire sagittal section of an egg in which the amnio-proctodaeal cavity is getting deeper, with the germ cells within the pit. 3μ; Fe. H. 34×.
24. Section of amnio-proctodaeal cavity with the germ cells passing into the walls. Cells remaining within the cavity only slightly resemble germ cells. 3μ; Fe. H. and O. G. 588×.
25. Section of the amnio-proctodaeum of a more advanced stage, with the origin of the Malpighian tubules. A germ cell which was never included within the cavity is shown below. Some germ cells are left within the cavity, and one germ cell is seen on the dorsal side of the enteron rudiment. Adjacent sections showed more of these germ cells. 4μ; E. H. 270×.

PLATE III

26. Magnified drawing of portion of the cross-section indicated in Figure 27. Germ cells on the dorsal side of the enteron rudiment which is growing over and around the yolk. Germ cells are also visible on the side of it. Cells which stain like germ cells are also found scattered within the rudiment. 4μ; Fe. H. 588×.
27. Entire cross-section of embryo through the posterior region, slightly oblique, so that Malpighian tubule is cut on one side and not on the other. Tracheae are beginning to form. 4μ; Fe. H. 64×.
28. Sagittal-section of an egg showing Malpighian tubules, germ cells on the posterior rudiment. 3μ; Fe. H. 140×.
29. Germ cells associating with mesodermal cells, taken from a section corresponding to the one shown in the previous figure, but from the other side of the body of the same embryo. 4μ; Fe. H. 588×.
30. Gonad from a later stage embryo. Formation of the dorsal body wall. Stomodaeum in this embryo had moved to the anterior end. The entoderm cells acquiring their typical vacuolated structure. 4μ; Fe. H. 140×.
31. Cross-section of embryo about the middle of the body, showing the origin of the mesoderm. 3μ; E. H. 64×.
32. Twin eggs inside the uterus. The cleavage nuclei invading the periphery of the eggs. 4μ; Fe. H. and O. G. 34×.
33. Sagittal-section of embryo showing position of gonad within the body. 3μ; Fe. H. 34×.
34. Twin eggs inside female uterus. Older stage, with stomodaeum in anterior position. 3μ; Fe. H. and O. G. 34×.
35. Cleavage spindle in an egg containing 76 cleavage nuclei mostly in spindle form with centerosomes and asters. 3μ; Fe. H. 588×.
36. Cleavage spindle from an egg containing 409 cleavage nuclei. The asters are prominent, but no centrosomes were seen. Chromosome fragments on the spindle. 4μ; E. H. 588×.
37. Somatic cell showing the 16 chromosomes on the equatorial plate in the metaphase stage. The cell is drawn from the proliferating germ band around the place of origin of the anterior proliferation, taken from the same embryo as Figure 20. 4μ; Fe. H. 588×.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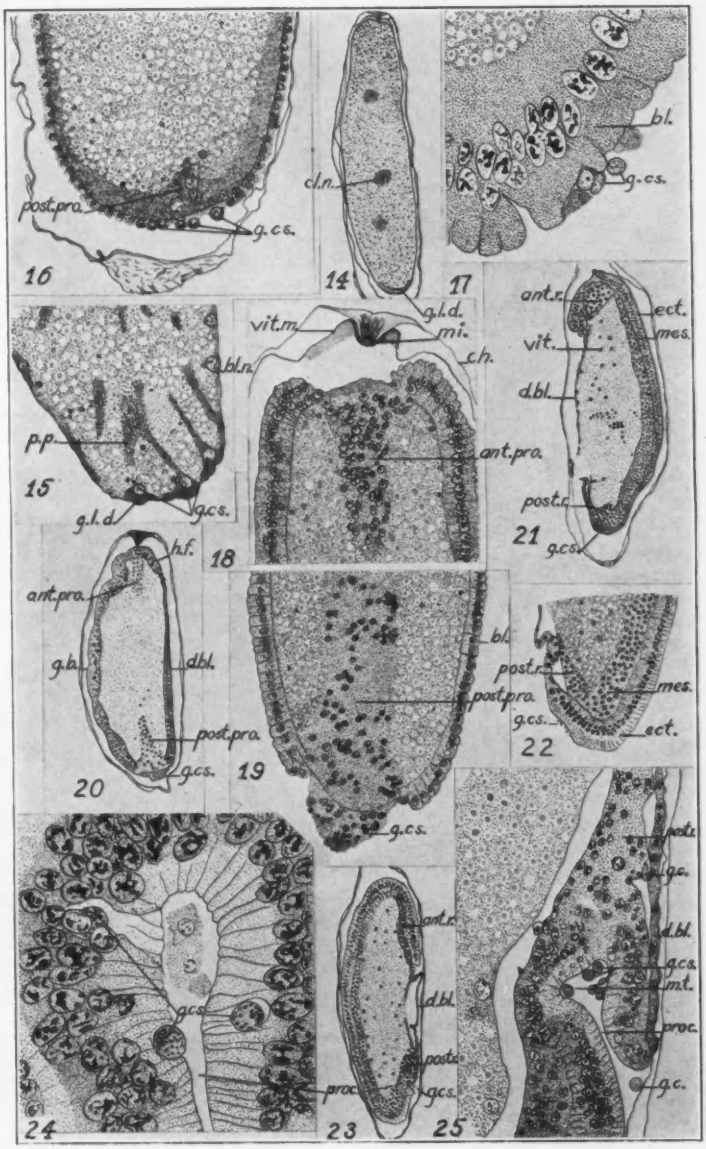
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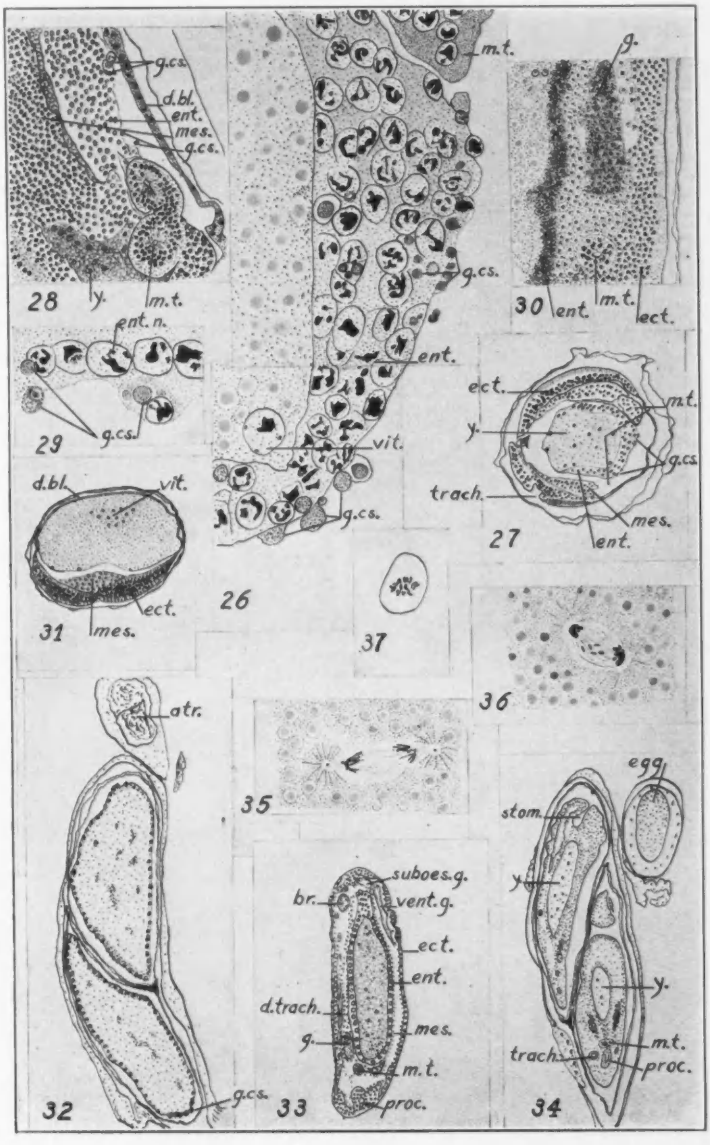
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THE MALE AND LARVA OF ANOPHELES (KERTESZIA) BOLIVIENSIS THEOBALD

(Diptera, Culicidae)[1]

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During the course of a mosquito survey made in the vicinity of Restrepo, in the Intendencia of Meta, not far from Villavicencio, the capital of the province, in Colombia, female specimens of what is thought to be *Anopheles* (*K.*) *boliviensis* Theobald were obtained, biting freely by day in the jungle, and numerous at horse-bait. Owing to the shortness of the time available, search for the unknown larva and male was unsuccessful. However, in January, 1936, the junior author succeeded in breeding from larvae found in bromeliads near Restrepo two males of this species. The corresponding larval skins were preserved.

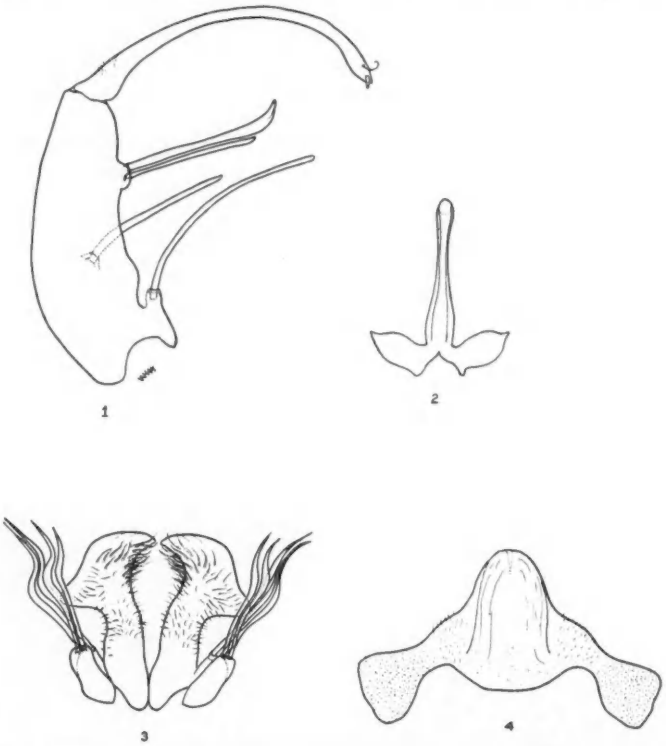
This species was described in 1905 by Theobald (1), from Songo, Bolivia, from a single female. The authors have not succeeded in discovering this locality on recent maps, although search was made in the map files of the Pan American Union in Washington, D. C. However, on page 32 of a volume by Gordon MacCreagh (2) a locality called the Songo Pass, apparently some days' journey northeast of LaPaz, Bolivia, on the eastern slope of the Bolivian Andes, is mentioned. This is possibly the locality given by Theobald.

The species remained further unknown until 1911, when C. H. T. Townsend, then Entomologist to the Peruvian Government, obtained 10 female specimens from Peru, the localities being Huascaray and Rio Charape, in the Province of Jaen, on the eastern slope of the Andes (3). This material is in the U. S. National Museum at Washington, D. C., where it was examined by the senior author in December, 1935. All the specimens have abdominal scales, agreeing with Theobald's description, and with the authors' material taken on the eastern slope of the Andes in Colombia.

Both Dyar (4) and Knab (5) believed that Theobald was in error in stating that *boliviensis* possessed abdominal scales, although Townsend's

[1]The studies and observations upon which this article is based were made under the auspices and with the support of the International Health Division of The Rockefeller Foundation, co-operating with the United States Public Health Service and the Servicio de Fiebre Amarilla of the Departamento Nacional de Higiene of the Republic of Colombia.

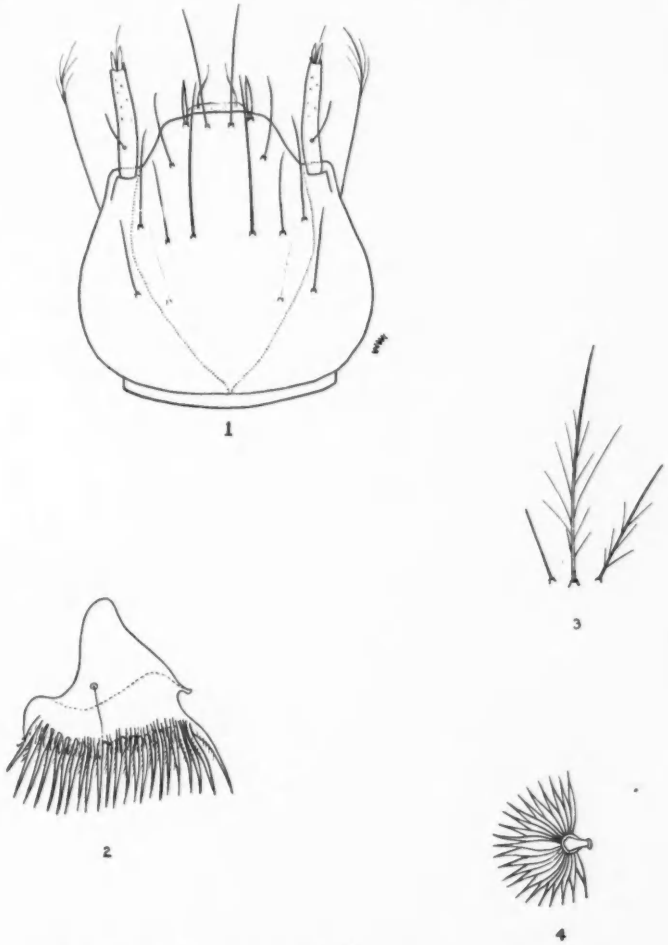
material, which was before them, shows such scales plainly. The only discrepancy between Theobald's description and that of the material taken by the writers is in the coloration of the hind tarsal segments. Theobald states that "the greater part of the second hind tarsal is white, (a minute black base), the other hind tarsals dark brown." In the Colombian and Peruvian material the second to fifth hind tarsal segments have black bases and white tips. As the other species of



TEXT FIG. 1. Male terminalia of *Anopheles boliviensis* Theobald. 1, Sidepiece; 2, Mesosome; 3, Harpagones; 4, Ninth tergite and anal lobe.

Kerteszia are quite variable in coloration, it is possible that Theobald's single female was a melanotic form, but it is equally possible that another *Kerteszia* species with abdominal scales and dark hind tarsi exists in Bolivia. However, until further collections are obtained from the eastern slope of the Andes in Bolivia, if this be the locality from whence the type specimen came, it is assumed that the species taken by Townsend in Peru and by the writers in Colombia is the *boliviensis* of Theobald.

The females of this species taken by the writers in Colombia resemble *Anopheles (K.) bellator* D. & K. (or *A. (K.) cruzii* D. & K.) very closely, except for the scaling of the abdomen, and in the palpi, which are black



TEXT FIG. 2. Larva of *Anopheles boliviensis* Theobald. 1, Head; 2, Pecten; 3, Submedian prothoracic hairs; 4, Palmate hair.

in *bellator*, and tipped and banded with white in *boliviensis*. The scales on the dorsum of the abdomen of *boliviensis* are rather long, some obovate, some with truncate tips, dark brown, and concentrated on the apex of the segments. Sometimes a few white scales are intermixed.

On the sternites a transverse line of pure white, truncate scales, attached at about the middle of the sternite, is found on the second to fifth segments. There are numerous white scales on the sixth and seventh sternites. In addition to the scales, the segments are clothed with long brownish hairs. The two males from Colombia have the dorsum of the abdomen clothed with a mixture of large dark scales, some truncate, with similar pure white scales. Patches of white scales occur on the sternites.

Male terminalia: Side-piece (coxite) rather long, somewhat tapered towards tip, clothed outwardly with long setae and sparse long scales. Clasper long, slender, curved, the tip somewhat enlarged, with very small conical terminal spine. A minute patch of pilosity is near the base of the clasper, and one or two long setae near the tip. At the base of the side-piece, arising from a tubercle, is a single long sinuate parabasal spine, tapering, with blunt tip. About half-way up the sidepiece is a pair of accessory spines. The inner spine is longer and stouter than the outer, the tip flattened, widened, and blunt. The outer spine is more slender, shorter than the inner, tapered, with blunt tip. The internal spine lies between the parabasal spine and the accessory spines, and is long, slender, tapering, sinuate, with blunt tip. The mesosome is long, tubular, slightly expanded at tip, with no apparent leaflets. The harpago (claspette) is composed of two lobes, dorsal and ventral. The dorsal lobe bears two sets of filaments arising from tubercles. The filaments are long, slender, flattened, sinuate, widened centrally, the tips long and pointed. The ventral lobe is flattened, narrow at base, the apex abruptly expanded into a thin membranous structure, the inner margin thickened, straight, the outer edge thin, basally expanded, sinuate. The membrane is heavily clothed with slender curved setae, dense on the inner margin, the outer margin bare. Anal lobe rounded conical, membranous, pilose basally. Ninth tergite membranous, without processes.

Larva: Preclypeal spines very long and slender. Anterior internal clypeal hairs long, simple, slightly further apart than the distance between them and the outer clypeals; anterior external clypeal hairs very stout, short; posterior clypeal hairs long, slender, well behind the anterior hairs; subantennal hair very long, exceeding the tip of the antenna, finely branched at tip; all six frontal hairs simple, the inner pair the longest and strongest, the middle pair set close to these, somewhat shorter, the outer pair inserted anterior to the middle pair, well separated from these. Inner occipital hair missing, but probably long and simple; outer occipital hair long, simple, inserted close to the suture.

Antenna rather short, scarcely tapered, with a few weak spines towards tip; sabres short, the terminal hair simple. A stout simple hair outwardly on shaft, about one-third the distance from base to tip.

Anterior submedian prothoracic group with long branched middle hair, the outer hair similar, but shorter and more slender; inner hair rather long, simple.

Palmate hairs on second to seventh abdominal segments, the single elements moderate, lanceolate, with pointed tips.

Spiracular apparatus rather small, the spiracular openings well separated, oval. Pecten small, the pecten-hair simple; with about 20

pointed teeth, equal, uniform, fringed on one side. Anal segment moderate, with small saddle, the lateral hair simple, long; apex of segment spiculate posteriorly, dorsally. Caudal hairs missing. Ventral brush weak, of many branched hairs.

The larval skins are in poor condition, so that all the characters cannot be made out. Most of the pleural hairs are missing, so that a description cannot be made.

The obvious differences separating the species from the common *A. bellator* of Panama are, in the female, the presence of scales on the abdominal segments; in *bellator* hairs only are present. The male terminalia differ from those of *bellator* in the form and length of the accessory spines; in *boliviensis* the outer spine is slender and considerably shorter than the inner spine, which has a flattened, widened blunt tip. In *bellator* the two spines are approximately equal in length, and the tip of the inner spine is not markedly flattened. The dorsal lobe of the harpago of *boliviensis* has only four or five long slender filaments, while in *bellator* these are apparently five or six, much stronger, and more expanded centrally. The ventral lobe of *boliviensis* is distinctive in shape, that of *bellator* being longer, oval in shape, with a fringe of setae from outer edge and tip. The mesosome is apparently identical in each species.

The larva of *boliviensis* differs from that of *bellator* in the shape and position of the clypeal hairs, and in the palmate hairs. In *boliviensis* these are nearly evenly spaced, while in *bellator* the internal clypeals are widely separated, and close to the outer clypeals. In *boliviensis* the outer clypeals are short and very stout, almost spine-like; in *bellator* they are fine and slender, and about half the length of the inner clypeals. In *boliviensis* the single elements of the palmate hairs are slender, lanceolate, with pointed tips, and in *bellator* they are lingulate, with straight truncate tips.

In regions where it is numerous, *Anopheles boliviensis* may have some importance as a vector of malaria, as it is avid for human blood, and bites freely in the jungle by day, as well as during the evening hours. N. C. Davis reports a stomach infection of a closely related species in Brazil. *Anopheles boliviensis* may also play a part in the transmission of the malaria of monkeys, should this disease be found to be prevalent among these animals in Colombia, as it is in some regions of Panama.

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ANTS OF THE GENUS PONERA IN AMERICA, NORTH OF MEXICO

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The species of *Ponera* numbering not more than from 75 to 100 occur throughout the tropical and temperate regions of the world. In America, north of Mexico only five species are known, regardless of the great amount of ant collecting that has been done. Practically all of these, with the exception of *Ponera coarctata* subsp. *pennsylvanica* Buckley are confined almost entirely to the southern half of the United States. Several of the species such as *inexorata* Wheeler and *ergatandria* Forel have been collected too infrequently for one to know very definitely the limits of their distribution.

With the exception of Wheeler's study of the habits of *Ponera coarctata* subsp. *pennsylvanica* (The Habits of Ponera and Stigmatomma. Biol. Bull. 2, pp. 44–56 (1900)) no detailed investigations have been conducted on the biology of our North American forms. It is generally known however that the ants form very small colonies of only a few dozen to a hundred or so individuals in the soil beneath objects or else in the rotting wood of stumps, logs, et cetera, as well as in the rich wood mold of forests. None of the ants have been observed to feed on honey-dew. Their preferred food is flesh. On account of their timid manner and subterranean habits the workers are not so commonly seen as are those of other ants.

The morphological characters of the workers and queens of our North American forms, while distinctive enough when one species is compared with another, are not so evident when one possesses only individuals of a single species. One who has not handled specimens of *Ponera* frequently is easily apt to become confused. The two species that are perhaps most likely to be mistaken for each other are *opaciceps* and *pennsylvanica*. In examining numerous specimens over a long period of years, the writer has been especially impressed with their variable color and sculpture, and likewise the difference in the length of their antennal scapes, and the shapes of their petioles. These facts in addition to the scarcity of literature for satisfactory identification of the ants has led the writer to prepare this paper. Herein a key is furnished for separating the workers of each species, descriptions are given of workers, queens and aberrants, the distribution of each species is listed and biological notes are furnished where it is thought they would be of interest. The males of the various species have not been described because it is believed that nothing short of a study of their genitalia would satisfactorily separate them.

Emery in the Genera Insectorum, Fascicule 118, pp. 88–89 (1911) characterizes the various castes and their aberrants as follows:

"*Worker.*—Head more or less elongate with the lateral borders faintly convex. Anterior border of clypeus more or less curved, or else prolonged as a large and rounded lobe. Frontal carinae short, the lobes covering the antennal insertions semi-circular. Mandibles triangular, large, the teeth small and scarcely protruding; maxillary palpi with two segments or a single segment. Antennae strongly thickened toward the end, the last segments much longer and larger, but not forming a clearly limited club, or else a club of five segments. Eyes small, sometimes atrophied or missing, placed well to the front. Thorax generally with the meso-epinotal suture distinct. Petiole surmounted with a thick scale or elevated node.

"*Female.*—Very similar to the worker, but larger, winged, with the eyes much more developed, also some ocelli; the scale of the petiole is higher and thinner than in the worker of the same species. There are occasionally some wingless intermediaries between the worker and female. With *P. eduardi* Forel, these examples have a certain constance; they have eyes larger than workers, but no ocelli; Mr. Forel considers them as workers and not as ergatogynes, he admits however, the dimorphism of the workers in this species.

"*Male.*—Winged form: scape generally shorter than the second segment of the funiculus, rarely a little longer. Thorax normal: mesonotum and metanotum differentiated as is the custom with winged ants; the mesonotum convex, dominating the pronotum. Petiole surmounted with a scale more or less thick. Pygidium generally terminating in a spine, rarely spineless.

"*Male.*—Ergatoid form (*P. ergatandria* Forel, *punctatissima* Roger, *ragusae* var. *santschii* Emery): Head almost like that of the worker. Mandibles developed as with the worker. Antennae of twelve or thirteen segments; scape a little more short than that of the worker; the funiculus is short and enlarges toward the extremity. Eyes small like those of the worker, sometimes missing. Thorax almost like that of the worker; the mesonotum of a single piece and the metanotum having disappeared from the dorsal surface of the thorax. Last segment of the gaster invaginated the one into the other.

"The male ergatoid of *P. eduardi* is exceptional in many regards; the head is similar to that of the winged male; the mandibles are very small, and without teeth; the scape is almost as short as with the winged male, but the funiculus is much more short; the segments of the gaster are not invaginated the one in the other. It is necessary to remark that the ergatoid male has only been found a single time with this latter species, the winged male being the normal male."

KEY FOR THE IDENTIFICATION OF THE WORKERS

1. External border of mandibles sinuate; base of epinotum laterally compressed; color ferruginous yellow.....**inexorata** Wheeler
   External borders of mandibles not sinuate..... 2
2. Petiole when viewed in lateral profile slender, subtriangular (that is, narrower dorsally than ventrally); body slender; color varying from light brown to pitch black.....**trigona** var. **opacior** Forel

Petiole when viewed in lateral profile robust, subrectangular (that is, approximately as wide dorsally as ventrally) 3

3. Head very finely punctate, shining; eyes extremely small (3–4 facets); color light brownish yellow or dirty brownish yellow; size 2.3–2.9 mm. (Florida, Texas) ..... **ergatandria** Forel

Head with coarser punctures, therefore subopaque or opaque; eyes with more than 3–4 facets; color normally brownish black or black; robust; size exceeding 3 mm 4

4. Head with dense, coarse punctures, subopaque; more common to the northern section of North America, but occurring also over the eastern half of the United States ..... **coarctata** subsp. **pennsylvanica** Buckley

Head densely, but more finely punctate, thus giving the general surface a subopaque appearance but lacking the coarse granular effect common to the species **pennsylvanica** ..... **opaciceps** Mayr

Ponera inexorata Wheeler

Wheeler, Psyche 10: 94–95 (1903), *worker, female*. Fig. 1.

"*Worker.*—Length: 2.75–3.25 mm. Mandibles long and flattened, with concavely sinuate lateral borders and about a dozen teeth, which are small and indistinct toward the base, but longer and more pointed toward the tips of the blade. Head distinctly longer than broad with concave occipital margin and subparallel sides. Clypeus broadly rounded in front, convex in the middle. Antennae rather slender, scape reaching to the posterior angle of the head, joints 2–5 of the funiculus fully as long as broad, the remaining joints longer than broad. Eyes very small, with at most 3–4 ommatidia in their longest diameter and situated about one-fourth the distance from the anterior to the posterior border of the head. Thorax with very distinct pro-mesonotal and meso-epinotal sutures; pronotum broader then the succeeding thoracic segments, rounded, with rather sloping anterior angles; mesonotum convex; epinotum laterally compressed, its basal portion in profile horizontal and nearly straight, its declivity flattened, with rounded sides, not carinate. Petiole decidedly narrower than the first gastric segment, its anterior surface flattened dorsoventrally but distinctly convex from side to side; posterior surface flat in both directions, so that the segment when seen from above is somewhat semicircular; seen from behind the border of the node is nearly circular in outline. Gaster of the usual form. Legs moderately stout, each tibia with a pair of spurs, one of which is pectinated.

"Surface of the body, especially the dorsal surface of the head, thorax, and petiole, shining. Mandibles with coarse, scattered, piligerous punctures. Head covered rather densely but not confluently with coarse piligerous punctures or small foveolae. Pronotum with similar but smaller and sparser punctures; neck and mesonotum finely corrugated above; meso- and metapleura similarly but more coarsely sculptured, subopaque. Petiole and gaster covered with piligerous punctures like those on the pronotum.

"Whole body clothed with pale yellow, reclinate or appressed hairs, among which there are longer, more scattered, suberect hairs, especially on the thorax and abdomen.

"Yellowish ferruginous throughout, mandibles, antennae, and legs somewhat paler. Epinotum, mesopleurae, and posterior gastric seg-

ments sometimes more reddish or brownish. Teeth of mandibles and anterior border of clypeus blackish."

"*Female* (dealated.) Length: 3.25 mm. Very much like the worker in form and coloration. Each ocellus with a small black spot at its margin. Head distinctly more opaque than in the worker, owing to a denser aggregation of the piligerous foveolae; the node is thinner antero-posteriorly and its anterior surface is very flat or evenly slightly concave from side to side. Alar insertions black."

Type Localities: Austin, San Angelo and Fort Davis, Texas (Wheeler). *Other Localities: Mississippi*—State College (M. R. Smith), Ripley (S. W. Simmons); *South Carolina*—Walhalla (M. R. Smith).

This species ranges from Costa Rica through Mexico into the southern section of the United States. It is apparently rarer than some of the other members of the genus, hence the few times it has been collected. As yet its definite range in the United States is more or less problematical.

The worker is characterized by its light yellowish ferruginous color, the shining appearance of the head, thorax and petiole, the subparallel sides of the head, and the sinuate external borders of the mandibles.

Wheeler states that he found *inexorata* rather rare in Texas. According to him, "it occurs in colonies not exceeding a dozen individuals and usually much smaller. I have found it only on dry hill slopes under rather small stones (limestone in central Texas, volcanic rock in the Trans Pecos)."

Ponera trigona var. **opacior** Forel

Forel, Trans. Ent. Soc. Lond., p. 363 (1893), *worker*.
Emery, Zool Jahrb. Syst. 8: 268 (1895), *all castes;* Mem. Acad. Sc. Bologna (5), 5: 296 (1895), *male*.

Worker.—Length: 2–2.3 mm. Head, excluding the mandibles, longer than broad, posterior border faintly emarginate, posterior angles rounded, sides convex. Eyes small, rounded, apparently composed of about 6 facets, placed about the anterior fourth of the sides of the head. Mandibles rather irregularly toothed. Scapes somewhat robust, not attaining the posterior border of the head; funicular segments 3–6 much broader than long, the terminal segment scarcely as long as the three preceding segments taken together. Thorax short, fairly robust, with distinct pro-mesonotal and meso-epinotal sutures; viewed in lateral profile the base of the epinotum appears to be of the same length as the declivity and meets the latter in a very distinct obtuse angle, the declivity faintly concave. Petiole when viewed in lateral profile not as robust as in the other species, very distinctly narrower (antero-posteriorly) dorsally than ventrally, strongly convex anteriorly, faintly convex posteriorly; viewed posteriorly the rounded superior border meets the lateral borders in such a way as to give an almost circular effect.

Body, due to the faint sculpturing and the nature of the pubescence rather glabrous, in some lights however somewhat subopaque. Head covered with extremely fine, dense punctures; thorax much less so;

pleurae of the meso-and metathorax, especially the lower parts, finely and longitudinally striated.

Pubescence extremely fine on all parts of the body but probably most apparent on the gaster and head, pubescence scarcely hiding the general surface of the body, but in some lights giving it a pruinose effect. Pilosity poorly developed; hairs grayish, most noticeable on the dorsal surfaces of the head and gaster, on the former strikingly long, on the latter short, except toward the apex of the gaster.

Color variable; ranging from light brown to practically black, appendages lighter.

Queen.—Length: 2.75–3 mm. Very similar to the worker but larger and more robust. As with the worker funicular segments 3–6 are much broader than long, and the terminal segment shorter than the preceding segments taken together. The most distinctive character is the shape of the petiole which is very narrow antero-posteriorly and clearly thinner above than at the base. The wing veins and stigma very light brown.

Type Locality: Island of St. Vincent, Lesser Antilles (Forel). *Other Localities: Alabama*—Naftel, Elmore, Ashford (L. C. Murphree); *Arkansas*—ElDorado, Camden, Hot Springs (D. E. Read); *California*—Palo Alto (H. Heath); *Colorado*—Canyon City (P. J. Schmitt); *Florida*—Jacksonville (Mrs. A. T. Slosson); *Georgia*—Gainesville, Okefenokee (J. C. Bradley), Vidalia, Mt. Vernon, Glenwood, Shady Dale (H. T. Vanderford); *Illinois*—Edwards County (A. Forbes), Urbana (H. H. Ross); *Kansas*—Locality? (W. P. Hayes); *Kentucky*—Ashland, Owensboro, Uniontown (H. T. Vanderford); *Louisiana*—Tallulah (P. A. Glick); *Mississippi*—Landon, Belzoni, Bond, Cedar Bluff, Columbus, Duck Hill, Fayette, Kilmichael, Quincy, Quitman, Shaw (L. C. Murphree and M. R. Smith), Lucedale (H. Dietrich), Tupelo (W. C. McDuffie), Ripley (S. W. Simmons), Aberdeen, State College, Boyle, Louisville, Adaton (M. R. Smith), Shaw (G. W. Haug); *Missouri*—Poplar Bluff (D. E. Read); *New Mexico*—Las Vegas (T. D. A. Cockerell); *North Carolina*—Bessemer City, Hot Springs (H. T. Vanderford); *Ohio*—Lower Salem (M. Schramm); *Oklahoma*—Wichita National Forest, Beckham and Comanche counties (W. Fisher); *Oregon*—Boundary line between Oregon and California (A. C. Cole); *South Carolina*—Walhalla (M. R. Smith), Calhoun, Prosperity, Westminister, Scranton, Charleston (D. E. Read); *Tennessee*—Montvale Springs (C. H. Kennedy), Knoxville (C. N. Ainslie), Sewanee, Morrison, Adamsville, Saltillo, Randolph (L. C. Murphree); *Texas*—Austin, McNeill, Marfa (Wheeler), Plano (E. S. Tucker), Paris (A. Rucker), Marshall, Commerce, Bryan (D. E. Read), Brownsville (T. F. McGehee).

This species is apparently distributed from Chile, South America, into the southern half of the United States and out into the islands of the West Indies. In Mississippi, it is our most common species of *Ponera*, ranging throughout the entire state, whereas *pennsylvanica* is confined more to the northern section of the state, and *opaciceps* to the southern.

P. trigona opacior is highly variable in color, sculpture and even in the shape of the petiole. From other species the worker can be distinguished by its slender, graceful appearance, finely punctate body, and distinctly triangular shaped petiole (viewed in lateral profile).

P. opacior has the same general feeding and nesting habits as other species of *Ponera*. Our records in Mississippi seem to indicate that the males and queens are produced from the middle of May to as late as the middle of August.

Ponera ergatandria Forel

Forel, Trans. Ent. Soc. London, pp. 365, 367 (1893), *worker, female, male.*
Emery, Bull. Soc. Ent. Ital. 28: 22 (1896), *female.*
Wheeler, Bull. Amer. Mus. Nat. Hist. 24: 405–406 (1908), *worker, female, male* (after Forel).

"*Worker.*—Length: 2.3–2.9 mm. Narrow and much elongated. Mandibles relatively short with 4 teeth in front and distinctly denticulated behind. Clypeus short, rather strongly two-notched in front. Frontal furrow longer than half the distance from the frontal carinae to the occiput. Eyes vestigial, of two or three facets, situated a little in front of the anterior fifth of the sides of the head. The scapes do not reach the posterior sixth of the head. The pronotum is longer than broad, much longer and narrower than in *P. foeda, trigona,* and *opaciceps,* not enlarged at its anterior corners, which are absolutely effaced. Epinotum as in *P. contracta,* but the basal surface is a little longer than the declivity, and the latter is not even marginate, but rounded on all sides. Petiole much narrower, lower and a little thicker than in *P. contracta,* otherwise of the same form. It is at least twice as broad as thick, of the same height as the first gastric segment. Gaster very long and narrow, hardly constricted behind the first segment, which is narrower, lower and less truncated in front than *P. foeda, contracta,* and *punctatissima.* Legs much shorter than in any of these species.

"Shining, finely punctate, like *P. contracta,* but the punctation of the head is finer.

"Pilosity and pubescence longer and paler, very apparent.

"Body sordid brownish yellow, with the lower portion of the head, certain portions of the thorax, and the middle of the gastric segments deep brown. Legs, antennae, mandibles and tip of abdomen more or less pale, sordid yellowish or brownish."

"*Female.*—Length: 2.7–2.9 mm. Shorter and broader than the worker, otherwise presenting the same characters, but more deeply and strongly sculptured. Wings subhyaline; veins and stigma very distinct. Much smaller than the females of the European species."

"*Male.* Length: 3 mm. Apterous, ergatoid; much elongated and very narrow. In other respects extremely close to the dimorphic male of *P. punctatissima* (*P. androgyna* Roger), but still more closely resem-

bling the worker from which it differs only in the following characters: It is blind with a small pigment spot in place of the eyes. Head elongated, rectangular, ¼ longer than broad. The scapes hardly reach to the posterior fourth of the head and are subclavate. Funicular joints broader and more widely separated from one another. The teeth of the mandibles are somewhat more obtuse. The clypeus is a little longer and less vaulted. The gaster has one more segment and the male genital organs are altogether normal; the scales are large, the external genital valvules short, triangular. The pygidium has no spine and the hypopygium is rounded. Pale sordid yellow; antennae and anterior portion of the head and middle of the gaster somewhat more brownish. The antennae, moreover, are 12-jointed and the narrow thorax is in all respects like that of the worker."

Type Locality: Island of St. Vincent, Lesser Antilles (Forel). *Other Localities: Texas*—New Braunfels (Wheeler); *Florida*—Belle Glade, Daytona Beach (D. E. Read).

This species has been collected in Costa Rica and in a number of the islands of the West Indies, as well as in the states of Texas and Florida. *P. ergatandria* is either extremely rare or absent from the other southern states, especially those of the Gulf Coast region.

This is the smallest of our North American *Ponera*. Workers of *ergatandria* can be recognized by their extremely small eyes (2–3 facets), short antennal scapes, and sordid brownish yellow color.

The writer has little information on the biology of this ant. As mentioned above the male is represented by an aberrant form which possesses a combination of both male and worker characters. During the middle of July, 1932, the writer received numerous winged females from Belle Glade, Florida, with the report that the ants were so numerous in the field as to annoy the negro laborers like mosquitoes. At night, it was stated, the ants experienced little trouble in passing through window screens.

Ponera coarctata subsp. **pennsylvanica** Buckley

Buckley, Proc. Ent. Soc. Phila. 6: 171 (1866), *worker*. *Ponera pennsylvanica*.
Emery, Zool. Jahrb. Syst. 8: 267 (1895), *all castes*.
Wheeler, Biol. Bull. 2: 44, Figs. 1–4 (1900), *all castes*.

Worker.—Length: 3–3.75 mm. Head, excluding the mandibles, very much longer than broad, sides moderately convex, posterior border faintly but definitely excised in the middle. Eyes very small, not convex, composed of approximately 6 ommatidia, placed toward the front of the head about one-fourth the distance from the base of the mandibles. Ocelli absent. Clypeus convex medianally. No distinct frontal area. Frontal furrow extending approximately half the distance from the frontal carinae to the posterior border of the head. Mandibles with two or three prominent teeth anteriorly, and many small denticulae posteriorly. Scape robust, not attaining the posterior border of the head; funiculus clavate, the terminal segment almost, or about as long as the three preceding segments together. Thorax laterally compressed, moderately convex dorsally, wider anteriorly than posteriorly; pro-meso-

notal and meso-epinotal sutures distinct. Epinotal declivity faintly concave with weakly marginate sides, meeting the base in a well rounded obtuse angle. Petiole thick antero-posteriorly, scarcely narrowed dorsally, convex anteriorly, concave posteriorly, beneath with a prominent rectangular tooth, the front of which bears a spiracular opening, the posterior of which terminates in a rather sharp tooth. Tibiae of legs each with a well developed pectinated spur.

Mandibles smooth and shining, with sparse, scattered punctures. Head and thorax subopaque, covered with dense and coarse, but not confluent, punctures; petiole and gaster more shining, finely and densely punctate or shagreened.

Entire body covered with rather dense, yellowish gray, appressed pubescence. Erect hairs on the head, thorax, petiole and gaster; most numerous on the latter. Hairs longest on the anterior and posterior ends of the body.

Typical specimens black; mandibles, clypeus, frontal carinae, antennae, legs, and tip of gaster reddish or yellowish. Occasionally individuals are reddish brown with varying amounts of infuscation.

Queen. Length: 4 mm. Resembling the worker in general appearance but larger and more robust. Head with large compound eyes which are placed slightly less than their greatest diameter from the base of the mandibles. Vertex with three ocelli in the form of a triangle. Petiole smaller, and more slender (anterio-posterially) than with the worker. Wings hyaline, ciliated, with yellowish veins and darker stigma; with one submarginal and a discoidal cell.

Type Locality: Near Philadelphia, Pennsylvania (Buckley). *Other Localities: Connecticut*—Colebrook (Wheeler); *Florida*—Monticello, Gainesville (Wheeler); *Georgia*—Spring Creek, Thalman, Burton, Atlanta (J. C. Bradley); *Illinois*—Danville (J. Alsterlund), Urbana (M. R. Smith), Normal, Centralia, Bloomington, Algonquin (Ill. Nat. Hist. Survey), Charleston, Savoy (C. O. Mohr), Galena, Herod, Harrisburg, Putnam, Lagrange (H. H. Ross), Herod, Zeigler, Makanda (T. H. Frison); *Indiana*—Grand Chain, Wyandotte (W. S. Blatchley); *Iowa*—Stanhope (G. O. Hendrickson); *Kansas*—Riley County (W. P. Hayes); *Kentucky*—Ashland, Vanceburg (H. T. Vanderford); *Louisiana*—Tallulah (P. A. Glick); *Maine*—Casco Bay (Wheeler), Sebago Lake (collector?); *Massachusetts*—Woods Hole, Brewster, East Falmouth (A. H. Sturtevant); *Michigan*—Charity Island (F. M. Gaige); *Mississippi*—State College, Corinth (M. R. Smith), Lucedale (H. Dietrich); *Missouri*—Columbia (M. Talbot); *Nebraska*—Lincoln, Warsaw (O. S. Bare); *New Hampshire*—Contoocook (E. and G. C. Wheeler); *New Jersey*—Camden (Fox), Lakehurst, Halifax (Wheeler); *New York*—Staten Island (W. T. Davis), Syracuse, Jamestown (E. and G. C. Wheeler), Ithaca (J. C. Bradley); *North Carolina*—Black

Mountain (Wheeler); *Ohio*—Columbus (M. R. Smith), Put-in-Bay (M. Talbot); *South Carolina*—Clemson College (M. R. Smith); *South Dakota*—Canton (H. C. Severin); *Tennessee*—Knoxville (C. A. Dennis), Great Smoky Mountains (C. H. Seevers), Parsons, Middleton (L. C. Murphree); *Virginia*—Lexington (H. T. Vanderford); *Maryland*—Locality? (Emery); *West Virginia*—Morgantown (G. C. Wheeler); *Wisconsin*—Madison (M. R. Smith).

P. coarctata pennsylvanica is apparently rather generally distributed over that section of the United States east of the 97th degree of longitude. Although rather common in the northern and eastern portions of this section, in others it is either sporadically distributed or absent from some places. In Mississippi for instance the species is apparently absent from the lower third of the state, is very rare in the central third and is only moderately common in the northern third. As mentioned elsewhere in this article, the ant ranges even into the eastern half of Canada.

The workers do not resemble those of any other species of *Ponera* except *opaciceps*. The elongated head, coarsely punctured head and thorax, subopaque appearance, and rectangular shaped petiole (viewed in lateral profile) will serve to distinguish the worker of this species from the other *Ponera*.

The biology of this species has been rather adequately covered by Wheeler. The reader is therefore referred to this interesting paper.

Ponera opaciceps Mayr

Mayr, Verh. Zool.-bot. Ges. Wien, 37: 536 (1887), *worker, female.*
Smith, M. R., Annals Ent. Soc. Amer. 22: 545 (1929), *male.*
Smith, M. R., Annals Ent. Soc. Amer. 24: 507–509 (1931), *ergataner;* Fig. 1, *worker;* Figs. 2, 3, *ergataner.*

Worker. Length: 3.2–3.4 mm. Head, excluding mandibles, longer than broad, posterior border faintly emarginate, the sides convex, and the posterior angles rounded. Eyes small, with approximately 10–12 facets, situated at a distance less than twice their greatest diameter from the base of the mandibles. Mandibles with more irregular teeth than with *P. pennsylvanica*, the front teeth not only larger but more regular. Clypeus convex medianly. No frontal area. A faint frontal furrow extends half the distance or beyond from the frontal carinae to the posterior border of the head. Scape not attaining the posterior border of the head; the funiculus clavate, the last segment apparently shorter than the three preceding segments. Thorax with distinct promesonotal and meso-epinotal sutures, not so laterally compressed, especially about the epinotum as with *P. pennsylvanica;* epinotal declivity faintly concave, with bluntly marginate sides, meeting the base in a well rounded, obtuse angle. Petiole viewed in lateral profile thick antero-posteriorly, scarcely narrower dorsally, convex anteriorly, concave posteriorly; viewed posteriorly the superior border merges into the sides in well rounded angles; tooth below although rectangular, apparently

lacking the spiracular opening in front, and the point posteriorly, as with *P. pennsylvanica*.

Head, thorax, petiole, and gaster very densely and finely punctate, subopaque; meso- and meta-pleurae finely and longitudinally striated; mandibles, and epinotal declivity rather smooth and shining.

Pubescence yellowish gray, dense and appressed, covering all parts of the body. Hairs grayish, very noticeable on the clypeus and gaster where they are longest and most abundant; usually found sparingly on other parts of the body.

Color varying from brown to black; mandibles, antennal funiculi, legs and tip of gaster lighter.

Queen.—Length: 3.7–4 mm. So similar to the worker as to hardly warrant a brief description. Very slightly larger. Compound eyes placed at a distance from the mandibles less than their greatest diameter. Frontal furrow extending to the anterior ocellus. Petiole proportionally smaller and narrower anteroposteriorly on the dorsal border than with the worker. Wings very hyaline, with light yellowish veins and stigma, each with a submarginal and discoidal cell.

Ergataner.—Length of head .68–.76 mm.; length of thorax .935–.965 mm. Head, including mandibles, longer than broad; posterior border almost straight, and sides subparallel, thus giving the head a more rectangular appearance than with the worker. Mandibles moderately broad, triangular, edentate stubs. Clypeus strongly convex, protuberant. Antennae 13-segmented, gradually but not strongly enlarging distally; scapes short, subcylindrical, approximately equal in length to the second, third, and fourth segments of the funiculi taken together. Compound eyes small, almost circular, separated from the base of the mandibles by a space equivalent to approximately one and one-half times their greatest diameter. Thorax short, robust; viewed laterally the pro-mesonotal and meso-epinotal sutures are very distinct, especially on the dorsum; mesonotum strongly gibbous, clearly projecting above the general surfaces of the pronotum and epinotum. Between the mesonotum and epinotum the suture is represented by a very strong constriction, following which, the epinotum forms a rather long and gentle arch terminating at the petiole. The basal surface and declivity of the epinotum merge into each other so gradually that they are hardly distinguishable. Petiole large, robust, anterior and posterior faces convex, superior border rounded. Gaster similar to that of the worker, but bearing prominent genital appendages.

Color sordid yellow; margins of compound eyes and antennal cavities black, articulations of legs and sutures of thorax brown.

The above description is based on two specimens which were taken from a colony of *Ponera opaciceps* at Landon, Mississippi, by G. W. Haug on August 25, 1930. No other ergataners of this species have been seen or recorded.

Type Locality: Province of Saint Catherine, Brazil (Mayr). *Other Localities: Alabama*—Montgomery, Inverness, Seale, Brantley, Loxley, Castleberry, Fowl River, Sellers (L. C. Murphree); *Arizona* — Lower Portions of Grand Canyon

(Wheeler); *Colorado*—Boulder (T. D. A. Cockerell); *Florida*—Royal Palm Park, Dunedin (W. S. Blatchley); *Georgia*—Sylvester, Glenwood, Preston, Nashville, Screven, Rockingham, Yatesville, Jesup (H. T. Vanderford); *Louisiana*—Waterproof, Cottonport, Torras, Schwab, Bunkie (T. F. McGehee); *Mississippi*—Landon, Bond, Columbus, Fayette, Quitman, Wiggins (L. C. Murphree and M. R. Smith), Prentiss (L. J. Goodgame), Ocean Springs, Perkinston (J. P. Kislanko), Fearns Springs (M. R. Smith), Lucedale (H. Dietrich), Carriere (L. E. Myers); *South Carolina*—Jacksonboro (D. E. Read); *Texas*—New Braunfels, Austin (Wheeler), Cleveland (L. C. Murphree), San Antonio (D. E. Read), Nederland, Port Neches, Matagorda (T. F. McGehee).

This species ranges from as far north as Boulder, Colorado, in the United States to as far south as Uruguay, South America, and throughout the islands of the West Indies. In Mississippi *opaciceps* is the most common species of *Ponera* in the southern section of the state but ranges as far north as Columbus.

The worker can be distinguished by the following characters: its larger size, proportionally broader and more finely punctate head than with *pennsylvanica*, and somewhat rectangular shaped petiole (when viewed laterally).

The biology of this ant is similar to that of the other species of the genus.

TERCEIRO CATALOGO DOS INSECTOS QUE VIVEM NAS PLANTAS DO BRASIL, by Dr. Angelo M. da Costa Lima. Pages 1–460. 1936. Published by the Ministerio da Agricultura, Departmento Nacional da Producçao Vegetal Escola Nacional de Agronomia, Rio de Janeiro, Brazil.

This impressive volume is the third of this type which has appeared from the pen of Doctor da Costa Lima, Chief of Laboratory at the Instituto Oswaldo Cruz. The first appeared in 1922 and the second in 1927, both as volumes of the Archivos da Escola Superior de Agricultura e Medicina Veterinaria.

This third volume is a list of Brazilian insects associated with Brazilian plants and is based on entomological, botanical and other biological articles and works which have appeared in the various governmental and scientific publications of Brazil. The volume opens with a "Bibliographia Entomologica" listing seventy-three such scientific serials published in that country. Next follows (pages 4–104) a bibliography by authors of all articles cited in the preceding list of journals, a total of 1,391 articles. The main body of the work (pages 105–382) is a list of 1,749 insects whose association with plants has been mentioned or discussed in the above Brazilian scientific literature. The volume closes with an index to the families, genera and species of insects listed and a similar index to the plants.

This is a volume valuable to those interested in neotropical entomology and agriculture and is one of interest to entomologists in general as it gives at once a broad view of the great amount of entomological and botanical work being carried on at present in Brazil. Seventy-three journals carrying this literature make no mean list. It is one to be proud of. Unfortunately for the non-language-minded North American scientist it is in Portuguese. Doctor da Costa Lima has for many years been a leader in the field of tropical biology and is one of the men responsible for its great development in Brazil.—C. H. K.

A REVISION OF THE NOCTUID GENUS BULIA WALKER (=CIRRHOBOLINA GROTE) (Lipidoptera)

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Bulia[1]

1858. *Bulia*, Walker, Cat. British Museum, 15: 1815, pro *Biula* Walker, *l. c.*, 13: 1169. 1857. (Type *propria* Wlk., sole species.)
1875. *Cirrhobolina*, Grote, Trans. Amer. Ent. Soc., 5: 117. (Contained *deducta* Morr. and *incandescens* Grt., the latter a synonym of the former.)

Proboscis well developed. Male palpi very long, second segment upturned, blade-like and extending well above vertex, third segment porrect, twice as long as broad, closely scaled (Fig. 4); female palpi upturned, almost as long as in male, third segment porrect. Antennae ciliated. Male head greatly modified (Figs. 3 and 4); front specialized, with slight blunt tuberculate prominence; dorsal part of head greatly modified by a pair of sheath-like projections which project forward between the bases of the antennae, the bases of these sheaths invaginated into the head in the region between the vertex and occiput, and the vertex in front of them depressed and modified; each sheath encloses a tightly packed mass of specialized scales of two types (Fig. 5), and between the sheaths is a strong median spine (Fig. 3); a peculiar upwardly directed tuft of scales from the frontal prominence and a large pointed tuft of hairs from special scale-areas of each side dorsally hide the head modification so that only the tips of the spine and sheaths project beyond the vestiture. Female head normal, front rough and rounded out; slight tuft reaching end of second segment of palpus. Fore tibiae unarmed; mid and hind tibiae with fringe of scales; mid tibiae of male swollen and enclosing tuft of long scales. Thorax and abdomen smoothly scaled. Venation: fore wing with veins 3 and 5 from near anal angle of cell, 6 from upper angle, 7 connate from end of areole with 8+9 which are long stalked, 10 from areole, 11 from cell; hind wing with cell almost half length of wing, veins 3 and 4 connate from lower angle of cell, 5 arising very close to 4 and rapidly diverging, 6 and 7 connate from upper angle, 8 touching cell at point only.

Male Genitalia: (Figs. 1, 6 and 8). Quite different in appearance from the *Melipotis-Drasteria* series proper. Symmetrical. Uncus with broad waved base, without terminal claw, with lateral fringe of long, *simple* setae. Anal tube short, scarcely longer than the moderate uncus. Scaphium well developed, strongly chitinized. *Subscaphium a well-developed, narrow, ribbed sclerite.* Tegumen broad and strong. Vinculum

[1]For notes on type specimens of the various names and for other assistance I owe thanks to Capt. N. D. Riley and Mr. W. H. T. Tams, of the British Museum; Mr. Marston Bates, of the Museum of Comparative Zoology (Harvard); Mr. Wm. Gerhard, of the Field Museum, and especially to Dr. Foster H. Benjamin, of the U. S. National Museum.

oval. Juxta strong, rounded or with scobinated processes laterally. Harpes slender, strongly chitinized except at tip of cucullus. Sacculus with a prominent, shelf-like projection near base, distally more or less produced into a curved hook which projects beyond the end of the cucullus. *Clasper, ampulla and clavus absent.* Aedoeagus slender and heavily chitinized, with large internal and large or small terminal spine, usually with minute spiculations on dorsal side near tip; vesica with many small cornuti in addition to larger spines. Eighth abdominal sternite and tergite greatly reduced. A pair of long, invaginated scale-pouches on eighth segment.

Female Genitalia: (Figs. 2, 7 and 9). Segment IX plus intersegmental membrane very long, over twice length of segment VIII, its apophyses in fully distended mounts reaching base of VIII. VIII moderate, incomplete ventrally, its apophyses slightly longer than the segment itself; *sternite VIII absent. Sternite VII indented at apex, with or without median prong.* Ostium opening broadly at apex of segment VII. Ductus bursae about as long as VII, with long ventral chitinization from ostium to near base of VII, slightly separated from short dorsal chitinization near bursa. Bursa wrinkled, with basal thick area of spines, apical lobe free of spines. Ductus seminalis arising from bursa.

Tympanum: (Based on *confirmans* and *deducta* only). Slightly atypical for *Melipotis-Drasteria* group. Hood oval with spiracle under it. Alula normal. Scutal phragma long, almost reaching pocket IV. Nodular sclerite curved, definitely pointed above, somewhat less so below. Tympanal membrane small. Pocket I enclosed, with small mouth and small pouch-like evagination; II moderate with small mouth, reaching III below or on both sides; III normal with small mouth, not fused with tympanal air-sac; IV double with large flange.[2]

As will be seen from the above description and accompanying figures, *Bulia* differs considerably from the *Melipotis-Drasteria* series proper in the palpi, male head, male and female genitalia, and somewhat in the tympanum. The venation and general pattern habitus are similar to *Melipotis*, *Drasteria*, etc. Unfortunately the early stages are unknown.

Key to Species

A. Hind wing with incomplete white lunule at anal angle; sacculus very slightly produced beyond cucullus (Fig. 1); sternite VII of female indented without median prong (Fig. 2). West Indies and northern South America ..... **confirmans**

AA. Hind wing with yellow lunule at anal angle; sacculus produced into a long claw beyond cucullus (Figs. 6 and 8); sternite VII of female indented with a median prong (Figs. 7 and 9). North America.

B. Juxta rounded, without scobinated prongs (Fig. 8).

C. Aedoeagus without any external spiculations; female unknown, **mexicana**

CC. Aedoeagus with area of small spiculations on dorsal side near tip (Fig. 8a); sternite VII of female with relatively short broad prong (Fig. 9) ..... **similaris**

BB. Juxta with two strongly scobinated prongs laterally (Fig. 6); sternite VII of female with relatively long thin median prong (Fig. 7) ... **deducta**

[2]The morphology of the tympanal structures and description of the nomenclature here used is given in detail in my earlier paper, "Comparative Skeletal Morphology of the Noctuid Tympanum," Entomologica Americana, n. s., 13 (1): 1–84, 1933. The tympanum of *B. deducta* is figured therein (Fig. 62).

confirmans Walker

1857. *confirmans* Wlk., C. B. M., 13: 1157. Type locality: San Domingo. type: ♀ in British Museum.
1857. *umbrosa* Wlk., C. B. M., 13: 1158. Type locality: San Domingo. Type: ♀ in British Museum.
1857. *propria* Wlk., C. B. M., 13: 1170. Type locality: San Domingo. Type: ♂ in British Museum.

Above synonymy based on photos of types of all three names and on compared with type specimens loaned by the British Museum. *Confirmans* is the light female; *umbrosa* the dark female; *propria* the normal male.

This is the only species of the genus in which the anal lunule of the hind wing is white.

Male Genitalia: (Fig. 1). Sacculus very slightly produced beyond cucullus. Juxta rounded. Aedoeagus with very small terminal spine and no spiculations on dorsal side near tip.

Female Genitalia: (Fig. 2). Sternite VII deeply indented, without a median prong. Bursa with relatively few spines.

Distribution: Cuba, Jamaica, Haiti, San Domingo, Marguerite Island, British Guiana, Costa Rica and Venezuela.

mexicana Behr, nec auct.

1870. *mexicana* Behr, Trans. Amer. Ent. Soc., 3: 27. Type locality: Casala, near Mazatlan, Mexico. Types: both destroyed.

Determination based on a single, topotypical male specimen in the U. S. National Museum. This specimen here designated as *Neotype*. No other specimens known to me. Maculation similar to some specimens of the following two U. S. species. Safely separable only by genitalia.

Male Genitalia: Differs from *similaris* (Fig. 8) in having a smaller lobe of the sacculus, a shorter aedoeagus with longer terminal spine and entirely without spiculations on dorsal side near tip.

similaris sp. nov.

=*deducta* auct. partim, nec Morrison.

It is useless to give a color description of this species or to try to separate it from *mexicana* or *deducta* by maculation. The two U. S. species have formerly been separated as to dark (*deducta*) versus light (*mexicana* auct.) hind wing, but this character is invalid. Holland's figures in "The Moth Book" will serve to identify the group; the genitalia must be examined to separate these three species.

Both *deducta* Morr. and this species vary greatly in maculation. As holotype of *similaris* I have picked a male not unlike Holland's figure (Pl. XXX, Fig. 36) though somewhat smaller in size. The allotype is somewhat darker but equally maculate. The paratypes show considerable variation along the same lines as that shown by *deducta*. The hind wing may be dark fuscous or only lightly marked. The Californian specimens (perhaps worthy of a racial name) are considerably lighter in color. Several of the Californian females show the same type of variation as *vulpina* of *deducta* (see below).

Male Genitalia: (Fig. 8). Juxta rounded, without lateral scobinated prongs, in some of the paratypes (not holotype) with a slight median "hump." End of "claw" of sacculus blunt. Aedoeagus with relatively strong spiculations on dorsal side near tip, a large terminal (internal) spine and a smaller median one, and an area of small cornuti near this latter spine.

Female Genitalia: (Fig. 9). Median prong of sternite VII short and broad, scarcely reaching beyond lateral prolongations of the sternum. There is some variation in the absolute length of this prong but the proportions of length to breadth are more constant. This prong in *similaris* is always short and broad in comparison to that of *deducta* which is long and narrow.

Types: (Except as otherwise indicated all types are in the U. S. National Museum.) Holotype, ♂, San Benito, Texas, March 16–23. In U. S. N. M. Allotype, ♀, San Benito, Texas, May 8–15. In U. S. N. M.

Paratypes, 2 ♂♂, Bee Co., Texas (1 in Cornell Univ. coll., 1 in author's coll.); 1 ♀, Corpus Christi, Texas, May; 2 ♂♂, 1 ♀, Cotulla, Texas, May 10 and 12, 1906 and 1907, at light (Crawford and Pratt); 1 ♀, Goliad, Texas, Nov., 1895 (E. A. Schwarz); 2 ♂♂, Kerrville, Texas, May 31. 1906 (F. C. Pratt); 1 ♀, Laredo, Texas, Sept. 1, 1925, (in author's coll.); 1 ♂, San Antonio, Texas, March 24–30; 1 ♀ San Benito, Texas, May 16–23; 2 ♀♀, Victoria, Texas, March 30 and April 9 (E. A. Schwarz); 1 ♂, 1 ♀, "Texas"; 1 ♂, 1 ♀, Baboquivari Mtns., Pima Co., Arizona, elev. 5,000 ft., June 15–30, 1923 (O. C. Poling); 7 ♂♂, 5 ♀♀, Loma Linda, San Bernardino Co., California, April and May (1 ♂ in Cornell Univ. coll., 1 ♂, 1 ♀ in author's coll., remainder in U. S. N. M.); 1 ♂, 1 ♀, Palm Springs, Riverside Co., Calif., April 16–23; 1 ♂, Sheep Creek, San Gabriel Mtns., Calif., April 25, 1931 (in author's coll.); 1 ♀, San Diego Co., Calif., April (Coquillet).

From several of these localities which furnished the types of *similaris*, and in some cases from the same lot of specimens, several or numerous specimens of *deducta* (genitalicly determined) were also obtained. Presumably then the two occur together, though *similaris* is rare and *deducta* common.

deducta Morrison

1874. *deducta* Morr., Proc. Boston Soc. Nat. Hist., 17: 220. Type locality: Waco, Texas. Types: ♂ at Museum Comp. Zool.

1874. *pavitensis* Morr., Proc. Boston Soc. Nat. Hist., 17: 220. Type locality: Waco, Texas. Types: ♀ at U. S. N. M.

1875. *incandescens* Grt., Trans. Amer. Ent. Soc., 5: 117. Type locality: Texas. Type: ♀ in British Museum.

1882. *mexicana* var. *vulpina* Hy. Edw., Papilio, 2: 14. Type locality: Prescott, Arizona. Type: ♀ in U. S. N. M.
1900. *mexicana* var. *albina* Stkr., Lepid. Rhop. Het. Ind. & Exot., Suppl. 3, p. 35. Type locality: Chihuahua, Mexico. Types: 2♀ in Field Museum.

Above synonymy based on genitalic notes on all types except that of *albina* Stkr. of which a compared with type specimen was examined genitalicly. *Deducta* and *pavitensis* are the "normal" male and female respectively (described as distinct because of the differences in the palpi now known to be sexual); *incandescens* is a very large female; *vulpina* is the form with the outer part of the fore wings "dull foxy-red"; *albina* is a light female, the name probably not worth retaining.

Holland figures the normal male under the name *deducta* (Pl. XXX, Fig. 36) and one of the usual females under the name "*mexicana*" (Pl. XXX, Fig. 28). The maculation varies greatly, some of the females being as maculate as the males. The hind wing may be either light or dark. Many females have the outer part of the fore wing partly or almost completely "dull foxy-red" (*vulpina*) though all intergrades to the more usual maculation occur.

Male Genitalia: (Fig. 6). Differs from all the other species in that the juxta is armed with strong, scobinated prongs laterally. Also the end of the "claw" of the sacculus is sharp; aedoeagus with or without *very* minute spiculations on dorsal side near tip, with a small terminal spine, a larger median spine, and an area of relatively large cornuti near the latter.

Female Genitalia: (Fig. 7). Median prong of sternite VII relatively long and narrow, well surpassing the lateral prolongations of the sternite. The absolute length is somewhat variable but in comparison with the width it is constantly much longer than in *similaris*.

Distribution: Arkansas, Colorado, Texas, New Mexico, Utah, Arizona and California. Strays reported as far as Orient, N. Y. (Latham). *Vulpina* I have seen from Texas and Arizona only.

Life History: Unknown, but there is a specimen in the U. S. National Museum from San Diego, Texas, May 20, 1895 (E. A. Schwarz) labeled "bred from larva on mesquite."

OTHER NAMES THAT HAVE BEEN ASSOCIATED WITH THIS GENUS

Cirrhobolina tetrica Hy. Edw. (Pac. Coast Lep., No. 29, p. 10. 1878) is a synonym of *Melipotis jucunda* Hbn. as positively shown by the genitalia of the only existing type, a female in the American Museum of Natural History (erroneously given as a male in the original description and in the list of A. M. N. H. types; but I believe not a spurious type). It is a Californian specimen of *jucunda* with a well-developed anal lunule such as I have seen rarely in other specimens.

Brunnearis Guenee (1852) has been suggested as a prior name for *confirmans* Wlk. Capt. N. D. Riley of the British Museum has kindly examined the unique female type and tells me it is not the same as *propria* Wlk. He says it "is a much larger species, with more pointed wings, and clearly belonging in the assemblage Hampson had arranged here as *Gespera perpendicularis* Guenee." A compared with type female loaned me confirms this placement.

EXPLANATION OF PLATE

Fig. 1. Male genitalia of *Bulia confirmans* Wlk.

Fig. 1a. Aedoeagus of same with vesica partly distended. Specimen from Kingston, Jamaica.

Fig. 2. Female genitalia of *Bulia confirmans* Wlk. Specimen from Petioneville, Haiti.

Fig. 3. Dorsal view of head of male of *Bulia deducta* Morr., showing sclerite modifications.

Fig. 4. Dorso-lateral view of head of male of *Bulia deducta* Morr., showing head modifications and structure of palpi. Specimen from Colorado.

Fig. 5. Setae from sheaths on head of male of *Bulia deducta* Morr., showing two types.

Fig. 6. Male genitalia of *Bulia deducta* Morr.

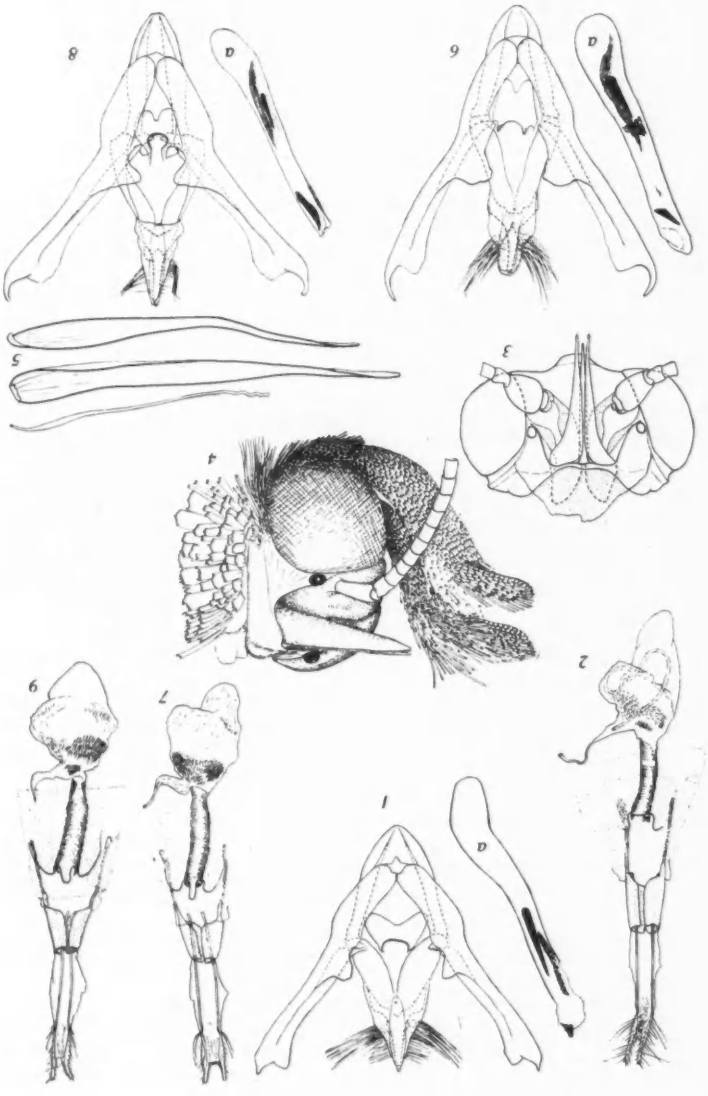
Fig. 6a. Aedoeagus of same, the dorsal side towards the left. Specimen from Indio, Calif.

Fig. 7. Female genitalia of *Bulia deducta* Morr. Specimen from Sanderson, Texas.

Fig. 8. Male genitalia of *Bulia similaris* sp. nov.

Fig. 8a. Aedoeagus of same, the dorsal side towards the left. Paratype from Bee Co., Texas.

Fig. 9. Female genitalia of *Bulia similaris* sp. nov. Paratype from Laredo, Texas. The allotype and most of the paratypes have a slightly shorter median prong than this specimen. This one represents approximately maximal length.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WINTER MORTALITY OF LARVAE OF THE EUROPEAN PINE SHOOT MOTH, RHYACIONIA BUOLIANA SCHIFF., IN CONNECTICUT[1]

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The severity of the winter of 1933–34 in contrast with the two previous winters afforded the writer the opportunity of observing the effect of winter temperatures on the survival of larvae of the European pine shoot moth. These observations are included here together with the results of some laboratory experiments on lethal low temperatures. An explanation is suggested for the course of development of the shoot moth outbreak since the introduction of the insect into Connecticut in 1914.

The larvae of the shoot moth winter in a semi-dormant condition within the buds of the infested host tree, or on the surface of the buds under an encrustation of pitch formed as a result of their feeding activities. Red pine is the principal host tree for this region. The larvae are inactive in the field when low temperatures are current, but a period of an hour or two at room temperature in the laboratory suffices to bring them again to the active condition. Studies have been made of infested tips collected at weekly to fortnightly intervals throughout the duration of larval life from July to the following May for each of three years from 1931 to 1934.

During the first two years of this investigation infested tips were collected at two different pine stands in Hamden, Connecticut. During 1933–34 collections were made in Middlefield (Mt. Higby) and near North Branford (Rose Pond). In addition less frequent visits were made to numerous plantations in the vicinity of New Haven. In the spring of 1934 much information was obtained in connection with control work carried on by the Civilian Conservation Corps and also some investigations by members of the staff of the Connecticut Agricultural Experiment Station. The information has been made available through the courtesy of this Station.

In the following discussion of mortality, which is based on the number of living larvae per infested tip of a branch, it must be borne in mind that the majority of the figures presented represent a minimum mortality, excepting of course the cases of 100 percent. The actual mortality cannot be calculated since the initial population at the time of eclosion from the egg stage is not known. As will presently be shown, a uniform decline in the population takes place after the larvae begin

[1]Submitted to the Faculty of the Graduate School, Yale University, in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

to feed on the buds unless some factor such as lethal low temperature enters the environmental picture. However, only observation over a period of years would make possible the definition of normal winter mortality with which the fluctuations of individual years could be compared. In 1932–33 the larval population, based on the number of living larvae per infested tip, fell from 2.76 in August to 0.45 the following April, showing a mortality of 83.7 percent. During the next year a population drop from 0.87 in July to 0.5 in April was recorded, showing a mortality of 42.5 percent. The data obtained over this two-year period are plotted in Figure 1. The fairly constant rate of decrease of population is evident for both periods.

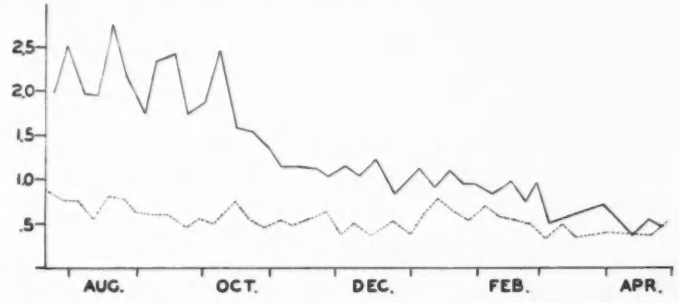

FIG. 1. Number of larvae *per infested* tip determined from the examination of tips collected throughout the larval period. Solid line represents 1931–32 data; broken line, the 1932–33 data.

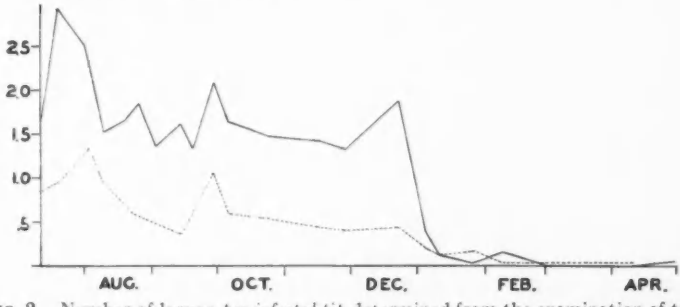

FIG. 2. Number of larvae *per infested tip* determined from the examination of tips collected throughout the larval period. Solid line represents data for Mt. Higby; broken line, data for Rose Pond, 1933–34.

During 1933–34 one study showed a population dropping from 2.92 to 0.04 larvae per infested tip (Mt. Higby), a mortality of 98.6 percent. In the second case (Rose Pond), with a drop from 1.32 to 0.04, the mortality was 96.9 percent. In computing these mortalities the highest point in the curve was chosen to represent the initial population in each case since we know that some mortality occurred very early in the larval period. The curves for the 1933–34 data are plotted in Figure 2.

In each curve there is a rise during late September or early October, probably accounted for by the fact that majority of the larvae which previously have been feeding in the needles, and are exceedingly difficult to detect in many cases, shift their feeding activities to the buds at about this time and become more conspicuous. If some period in the fall is arbitrarily chosen, what occurred up to that time can be shown. Taking late November-early December as the period, the mortality was 58.7 in 1931, 56.3 in 1932, 55.1 percent at Mt. Higby and 69.6 percent at Rose Pond in 1933. These percentages, based on a single point chosen in a fluctuating curve, are obviously approximate. However, in each of the three years a decline in population followed the same general course during the fall, accepting some variation for local differences in environment.

In 1933–34, but not in the other winters, a sudden increase in mortality about the first of the year is shown by a drop in the curves.

TABLE I

MORTALITY COINCIDENT WITH COLD PERIOD OF DECEMBER, 1933

Area	Number Tips Examined	Number Live Larvae	Number Live per Tip	Number Dead	Number Before Cold Period	Percent Mortality Coincident with Cold
1	30	4	.13	8	12	66
2	30	4	.13	21	25	84
3	50	7	.14	12	19	63
4	60	10	.17	27	37	73
5	70	9	.13	103	112	92
6	50	5	.10	24	29	83

Particularly is this true for Mt. Higby where there was a larger original population. This sudden increase is believed to have been due chiefly to a period of cold which occurred during the last week of December, 1933, when minima from —8 to —12 degrees Fahrenheit occurred in the vicinity of New Haven. Early in January collections of infested tips were made in six different plantations and the number of live and dead larvae in each collection determined. There is good reason to believe that practically all of the dead larvae had died coincident with the occurrence of the cold temperatures as indicated by their condition when examined. The information secured is given in Table I.

Area 1. is the Rose Pond plantation and area 5. the one at Mt. Higby. For these two plantations the mortality up to this time can be estimated. At Rose Pond it was 90.2 percent and at Mt. Higby 95.5 percent. This is a significant increase over 69.6 and 55.1 percent respectively about the first of December.

Because of the heavy mortality during the winter of 1933–34 but not during the two previous winters, daily temperature minima during the winter period of December through March for the three-year interval beginning with the winter of 1931–32 have been compared.

Distinctly lower minima occurred during the winter of 1933–34 in contrast to those of the two previous winter seasons, according to data taken from the Annual Meteorological Summaries of the New Haven Station of the United States Weather Bureau. Temperatures in the center of New Haven, where the station is located, generally run about five degrees higher than in outlying regions according to information secured at the Weather Bureau. A comparison of temperatures recorded at New Haven and Mt. Carmel, seven and one-half miles north, showed this clearly. At the latter place the records were taken by the Entomology Department of the Connecticut Agricultural Experiment Station and made available to the writer through the courtesy of that Department. For the winter period the minimum daily temperature at Mt. Carmel averaged 5.27 degrees Fahrenheit lower than at New Haven. The maximum, however, was only 1.57 degrees lower, indicating that the range of temperature was greater outside New Haven.

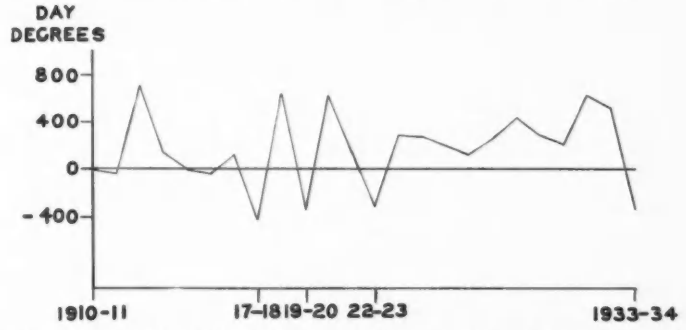

FIG. 3. Summary of day-degrees above or below normal for the period December through March of the winters of 1910–11 through 1933–34.

It is generally recognized that lethal low temperatures do not necessarily depend on the intensity factor alone. The quantity factor may be of importance when moderately low temperatures persist for a long period of time.

Since the past three winters have diverged so far from normal, it was felt advisable to study the temperature records over a period of years, beginning with the winter of 1910–11. As an indication of the trend of each winter, a summary of day-degree deviations, in degrees Fahrenheit, from normal daily means for the period of December through March was made. (Figure 3.) It will be observed that for a ten-year period previous to the winter of 1933–34 there was an excess of day-degrees for each winter. The winters of 1931–32 and 1932–33 were the fourth and fifth warmest occurring during the twenty-four year period investigated. It is apparent that the winter of 1933–34 shifted suddenly and strongly from the trend of the previous ten years, the deficiency being over 300 day-degrees. Such a deficiency, however, was not without precedent but was of the same order as occured in the winters of 1917–18, 1919–20, and 1922–23.

The European pine shoot moth was first reported in Connecticut in 1914. According to Busck (1915) the species had been repeatedly introduced into the United States on European nursery stock, and had become established in nurseries and parks located in nine different states. These states were: Illinois, Ohio, West Virginia, Pennsylvania, New Jersey, New York, Massachusetts, Connecticut, and Rhode Island. It is important to note that while the shoot moth was not abundant in 1914, it had become established. It was not until 1926, however, that the insect began to attract attention as a forest pest.

TABLE II

MINIMUM TEMPERATURES OCCURRING SINCE THE WINTER OF 1910–11
(New Haven)

Year	MINIMUM TEMPERATURES, F.°					Day-Degrees Deviation from Normal
	Dec.	Jan.	Feb.	Mar.	Season	
1910–11	5	10	7	14	5	—16
1911–12	17	—6	—2	13	—6	—34
1912–13	17	14	7	10	7	706
1913–14	17	—5	—7	15	—7	141
1914–15	—1	11	12	16	—1	—6
1915–16	15	6	—2	3	—2	—34
1916–17	14	4	—2	16	—2	113
1917–18	—12	—7	—7	13	—12	—422
1918–19	17	5	16	19	5	643
1919–20	—4	—4	—10	10	—10	—325
1920–21	10	1	7	24	1	624
1921–22	2	3	—5	15	—5	120
1922–23	12	3	4	7	3	—311
1923–24	21	0	8	20	0	288
1924–25	9	—3	12	11	—3	271
1925–26	6	3	9	12	3	1
1926–27	6	—1	15	17	—1	119
1927–28	11	10	2	16	2	261
1928–29	16	5	14	10	5	415
1929–30	6	10	1	18	1	294
1930–31	6	7	9	26	6	205
1931–32	17	23	15	14	14	623
1932–33	3	11	10	11	3	518
1933–34	—8	5	—15	10	—15	—331

The time for the shoot moth, under favorable conditions, to become a serious factor in a plantation following its introduction varies from three to five years (Friend and West, 1933). It is necessary to explain why no serious outbreaks occurred for a period of twelve years following the introduction of the insect. If a winter such as the past one results in a heavy mortality, then a certain correlation can be established between the history of the shoot moth outbreak in Connecticut and the winter temperatures occurring since the introduction of the insect.

Before establishing this correlation it is advisable to consider the actual minimum temperatures which have occurred as well as the

critical undercooling point which is lethal for the larvae. Table II shows the lowest minimum occurring for each month, the lowest for each winter, and, for comparative purposes, the summaries of the day-degree deviations from normal winter temperature. March is included since temperatures within the freezing range of larvae do occur in that month.

The three lowest temperatures recorded, —15, —12, and —10 degrees Fahrenheit, occurred during the winters having the greatest day-degree deficiencies, but the only other winter with a deficiency of a similar order, —311 in 1922–23, had a minimum of only 3 degrees. In general, though, there is a correlation between the minimum temperature and the deviation from normal temperature expressed in day-degrees.

TABLE III

INTERNAL AND EXTERNAL BUD TEMPERATURES

Size of Bud	Rate of Lowering of Temperature	Temperature, C.° at which Internal Equaled External	Time	Maximum Lag of Internal Temperature
Small (10–12 mm. length)	Rapid	—28.5° C. (—19.3° F.)	10 min.	10.6° C. (19.08° F.)
Medium (18–20 mm. length)	Rapid	—32.8° C. (—27.0° F.)	17 min.	9.0° C. (16.2° F.)
Small	Slow	—24.8° C. (—12.6° F.)	38 min.	2.9° C. (5.2° F.)
Medium	Slow	—24.7° C. (—12.5° F.)	32 min.	2.1° C. (3.8° F.)

In laboratory tests the undercooling point of the larvae was determined by a contact thermo-electric method essentially as described by Robinson (1927, 1928 a, 1928 b). In 50 tests the undercooling points varied between —11.97 degrees Centigrade (10.5 degrees Fahrenheit) and —28.27 degrees Centigrade (—18.9 degrees Fahrenheit). The mean undercooling point was —20.24 degrees Centigrade (—4.4 degrees Fahrenheit). In the field it would be necessary for a temperature lower than the average undercooling point to occur in order to be effective. No attempt was made to distinguish the effect of intensity and quantity factors, or that of rate of lowering of temperature.

The so-called undercooling point is stressed rather than the freezing point since it is the former figure that is biologically significant for insects which may normally be exposed to lethal low temperatures. According to Uvarov (1931) the temperature of the lethal point is the same as that of the undercooling point. Because of the large ratio of surface to mass of the larva, the lethal point is reached very quickly after the undercooling point is attained, and for practical purposes it may be considered that death occurs when the undercooling point is reached. No recovery following freezing occurred in any case.

Another factor considered was the possible protection afforded by the buds in which the larvae may be overwintering. When infested tips were subjected to low temperatures, the mortalities occurring at the various temperatures corresponded well with the determined lethal undercooling points, indicating little insulating effect of the bud or pitch mass. To further substantiate this several tests were made by placing a bud in the cooling chamber with one thermocouple internal and another external to the bud and noting the time required for the external and internal temperatures to become the same. The results are summarized in Table III.

In all cases where the temperature of the cooling chamber was allowed to rise the internal temperature of the bud lagged slightly behind the external temperature. The results of these experiments indicate that, since minima occurring in the field are usually of approximately four hours duration, and the rate of drop of temperature comparatively slow, the protection afforded the larva by the bud is a negligible factor.

In December, 1933, a minimum of 3 degrees Fahrenheit was recorded at New Haven. Even though lower temperatures may have occurred in the field, examination of infested tips failed to reveal any striking mortality which could be attributed to the current low temperatures. This and other field observations lead to the conclusion that a temperature well below zero must be attained before any significant mortality will result. The laboratory experiments already discussed bear out this conclusion, but the possibility that a few larvae succumb at higher temperatures is indicated by the range of undercooling points. No minima above 3 degrees are taken into consideration in the following discussion, since there is no indication that they effect a significant reduction in the larval population.

Following the introduction of the shoot moth into Connecticut, there occurred three fairly normal winters with day-degree deviations from the mean of —6, —34, and +113, which may have been favorable to the survival of the shoot moth. No exceptionally low temperatures were recorded. Any mortality which may have occurred had a proportionately greater effect than would a similar mortality occurring when the insect had become better established. A deficiency of 422 day-degrees was recorded in the winter of 1917–18, and a number of minima between 0 and —12 degrees occurred. In all probability there was a concurrent, unusually heavy mortality which would have retarded the progress of an outbreak.

In the winter of 1919–20, following a winter in which no temperatures within the lethal range below 3 degrees were recorded, and therefore probably favorable for the shoot moth, another large day-degree deficiency occurred. Again there is reason to assume a considerable mortality since there occurred several minima well within the freezing latitude and ranging down to —10 degrees. Having had but one favorable year in which to recover from the losses occasioned by the previous winter's low temperatures, the shoot moth could not have become very abundant by 1920. The winter of 1920–21 had a large excess of temperature and no minima below 1 degree. The following

winter was more nearly normal, but a minimum of —5 degrees occurring in February probably occasioned some mortality. In 1922–23 there was a deficiency of 311 degrees, but 3 degrees was the lowest temperature recorded. Consistent moderately low temperatures, such as occurred in 1922–23, possibly adversely affected the insect if the quantity factor of low temperature is an important consideration (Uvarov, 1931). Admitting this possibility, the thesis set forth here is not affected, since only one such winter occurred over a twenty-four year period. Regardless of this, it is doubtful if the shoot moth could have become at all abundant before 1923 because of frequently recurring unfavorable winter conditions since 1914.

During the ten-year period following the winter of 1922–23 temperature excesses were recorded each winter, ranging from 1 day-degree in 1925–26 to 623 day-degrees in 1931–32. During this interval of ten years the lowest minimum was —3 degrees and only eight minima below 3 degrees were recorded, so that no significant mortality should have occurred. Winter conditions during this period were extremely favorable for the development of a shoot moth outbreak which began at Easton in 1926 after four or five years during which the winter mortality was probably not an important factor. This length of time, it will be recalled, falls within that observed to be necessary for the shoot moth to become abundant in a locality. In the years following 1926 the insect became epidemic in many parts of Connecticut and continued so until 1934.

The effect of low temperatures occurring during the early part of the winter of 1933–34 has been mentioned. In February, 1934, a minimum of —15 degrees was recorded at New Haven, and this low temperature caused a severe mortality among the remaining larvae. The degree of mortality following this cold period was obtained for a number of plantations throughout the state. Most of the plantations were examined during April, and a few earlier in the year. The mortality for the State as a whole was high, being 100 percent in more than half the cases. These latter plantations are generally distributed throughout the state, while those having a lower mortality are for the most part distinctly localized in a belt extending from east of the Thames to west of the Connecticut river, in close proximity to Long Island Sound or associated bodies of water such as the Thames estuary. Unfortunately no plantations located along the shore line further west were examined. It is believed, however, that the lower mortalities were due to the less severe temperatures occurring along the shore as contrasted with those occurring further inland. A comparison was made of the minimum temperatures occurring during the winter of 1933–34 at New Haven, New London, and Cornwall (in the northwestern portion of the state). Whereas the minima at New Haven and New London closely paralled each other, those at Cornwall are consistently lower, and, it would seem, enough so to account for the many cases of 100 per cent mortality occurring in that region. An extreme minimum of —26 degrees was recorded at the latter place.

Extremely low winter temperatures such as sometimes occur in Connecticut temporarily depress the shoot moth population, but do

not necessarily eliminate the insect. Hence, the economic significance of such phenomena depends largely on the abundance of the insect. In 1933 the insect population was very dense in many plantations with correspondingly severe injury to the host trees. In the winter of 1933–34 a mortality of 95 percent or higher, such as occurred in many places, did not necessarily mean the permanent elimination of the insect as a serious pest. On the contrary the larvae were nearly as abundant the following fall. The explanation of this condition in the face of high mortality lies in the fact that the species has a high rate of reproduction. The effect of a heavy mortality, then, is often to maintain the population without allowing it to increase. Other environmental factors, either favorable or unfavorable, may disturb this situation. The relatively greater importance of a high mortality during the incipient stages of an outbreak is apparent. The insect will be prevented from increasing to a point where serious damage occurs, while when the epidemic stage is reached, a status quo is maintained which temporarily allays the damage being caused.

The importance of winter mortality in controlling the amount of injury is correlated with the feeding activities of the insect. Fall feeding may cause the death of many buds and the consequent loss of lateral growth. However, it is the feeding of the larvae in the spring that produces the most noticeable damage and results in so many crooks, "post-horns," and other malformations. A heavy mortality during the winter will mean comparative freedom from spring injury and a consequent greater amount of normal, undisturbed growth. This relief from serious injury may only be temporary in plantations such as the one at Rose Pond, which is a closed stand 20 to 25 feet in height, but in a younger plantation a heavy mortality occurring in a light infestation may conceivably mean the difference between success and failure of the stand. From field observations it is apparent that if the shoot moth is kept from becoming abundant until after the stand closes, the chances of its becoming a serious factor in the life of the stand thereafter are minimized.

Following the severe winter of 1933–34, recovery of heavily infested stands has been remarkable, but it is not expected to be permanent. In 1934, the amount of normal growth in heavily infested stands, as contrasted with the previous years, produced a much more healthy appearance. In practically no cases were dead terminals found. At Rose Pond all of the tips of this 1934 growth were infested during the summer of that year, and it may be expected that some serious damage will occur in the spring of 1935 unless the advent of lethal low temperatures again causes a heavy winter mortality.

A study of weather records show that the possibility is slight that the shoot moth will become a serious pest of red pine in the greater part of the natural range of this tree. Through central New England and New York there is an annual minimum isotherm of —10 degrees Fahrenheit, and a —20 degree isotherm extends through the northern part of this region as well as through northern Michigan and Wisconsin. Minimum winter temperatures of —30 to —40 degrees are annually recorded in the range of red pine in Canada north of Lake States as well

as in the Dakotas and Minnesota. Since heavy winter mortalities would be expected under such conditions, the development of an outbreak of the shoot moth is extremely unlikely. Certainly throughout a large part of the natural range of red pine minimum winter temperatures will control the distribution of the shoot moth and the amount of damage resulting from the activities of the insect. Bodenheimer (1927) suggests that it would be interesting to determine whether or not a two-year life cycle occurs in the northern portion of the native home of the species in Europe. The possibility of this two-year cycle occurring would seem remote certainly for North America where lethal low temperatures are apparently an important factor limiting the distribution of the insect in a region where it is known that under favorable conditions the species can complete its life cycle in a single year.

In view of the wide distribution of *buoliana* in Europe, it is of considerable interest to compare the temperatures occurring there with those recorded in this country. For European temperatures the Smithsonian "World Weather Records" publication of 1927 and "Andree's Handatlas" were consulted. Unfortunately no minimum temperatures are given, and it is on these rather than the mean that winter survival depends. However, knowing the means in North America and the fluctuations which occur, it is plausible to assume that similar fluctuations occur where like means obtain. The mean temperature at New Haven for January is about —2 degrees Centigrade (29.4° Fahrenheit). In Europe the isotherm belt where temperature means for January are between 0 and —10 degrees Centigrade (32° and 14° Fahrenheit) includes most of Germany, all of Scandinavia excepting the west coast of Norway, and Russia from the Baltic to the Ukraine. In eastern North America this belt extends laterally from New York to Montreal. In both cases the colder means of course occur on the north, and abnormally low minima occur in Europe at irregular intervals much as in the case in this country. In European literature reference is made to various outbreaks of the shoot moth. It would appear that temperatures prevailing during the winter may well have been influential in the development of the ourbreak or its decline.

It is felt that there is justification for the consideration of winter mortality as an important environmental factor. It is by no means implied that this is the only factor limiting the reproductive potential, or that it is at all times the controlling factor. Other environmental factors may be important in turn. However, the development of the shoot moth outbreak in Connecticut appears to be definitely correlated with the frequency of severely cold winters during the past twenty years.[2]

[2]While this paper was being written, during January, 1935, a period of cold weather occurred in Connecticut. In towns surrounding New Haven minima between —10 and —15 degrees Fahrenheit were recorded. At Rose Pond the population fell during this period from 0.4 to 0.16 live larvae per infested tip, a mortality of 60 percent. A sample of tips from Stamford showed a mortality of 89 percent for this period. In the latter place there was a heavier population previous to the cold spell. While this cold period will not be as far-reaching in effect as were cold periods during the previous winter, the resultant mortality will materially affect the amount of spring injury.

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A MONOGRAPHIC REVISION OF THE GENUS CEUTHOPILUS (ORTHOPTERA, GRYLLACRIDIDAE, RHAPHIDOPHORINAE) by THEODORE HUNTINGTON HUBBELL. Pages 1–551, 38 plates. 1936. A contribution from the Department of Biology, University of Florida, and the Museum of Zoology, University of Michigan. Published as University of Florida Publication, Biological Series, Vol. II, No. 1. Price (paper bound) $3.75.

We despair of being able to give Hubbell's Revision of the Genus Ceuthophilus an adequate notice in the limited space available. The work recognizes eighty-seven species and varieties, the majority of which are found within the borders of the United States. The camel or cave crickets are nocturnal insects which conceal themselves under rocks and rubbish in the daytime, hence are not represented by long series in the usual insect collection. After assembling the material in American collections Doctor Hubbell began extensive collecting by traps, cans baited with molasses. After fifteen years he had accumulated 17,000 specimens for this monograph. The author found that there are excellent genitalic characters for species definition the use of which placed the taxonomy of this group on a sound basis. The Museum of Zoology of the University of Michigan financed parts of his work, made him curator of Orthoptera and permitted his use of their artist Miss Grace Eager in the illustration of the work.

The first feature that attracts the eye is the extensive illustration. In Miss Grace Eager the author had use of the skill of one of the best illustrators of zoological subjects. The first seven plates carry 101 carbon-dust sketches by Miss Eager of the intricately folded genitalia. The remainder of the 843 figures are line drawings by the author. Following the 26 plates of drawings are twelve maps showing the known distribution of the forms discussed in the monograph.

The volume closes with twenty-two pages of "Observations on Life History, Habits and Relations to Other Organisms" which includes an extended discussion of the probable evolution of the subgroups in the genus.

This massive work will be a model for future monographers of insect genera. We can point out only a few of its excellencies: First a thorough study of the material already published upon, second an extensive collection in areas from which little material had been previously procured, third, the basing of species descriptions on genitalic characters and fourth the exacting care used in stating location of type material and its careful description. Fortunately the great bulk of the newer material, that collected by the author, is deposited in one place, the Zoological Museum of the University of Michigan. Unfortunately because of lack of funds the work as finally published is a very much condensed form of the original manuscript.

This has been an extensive undertaking, has covered a long period of years and is a model of exacting taxonomic work.—C. H. K.

THE GENUS NANNOCYRTOPOGON
(Diptera, Asilidae)

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The genus *Nannocyrtopogon* is here proposed for certain species of small western robber flies, two of which were formerly placed in the genus *Cyrtopogon*. As the genus *Cyrtopogon* is now one of the largest of the North American genera of Asilidae, it seems advisable to limit it where possible. The species included are apparently rare, and with the exception of one species have been taken only in the State of California.

Nannocyrtopogon, new genus

Closely related to the species of *Cyrtopogon* which have the scutellum flattened and pollinose. Differs in having the scutellum flattened and pollinose but without pile, and with strong marginal bristles. Mesonotum short, sparse pilose, with well developed lateral bristles, and usually well defined dorsocentral bristles. Abdomen bare, at most with longer pile on the sides of the first two segments, with the posterior angles and a transverse anterior band of most segments pollinose. Hind tibiae and metatarsi more or less thickened. The hairs of the mystax are stronger and less numerous than in *Cyrtopogon*.

Genotype: Cyrtopogon cerussatus Osten Sacken.

The genus as defined above is most closely related to the following species of *Cyrtopogon; rattus* Osten Sacken and *caesius* and *ablautoides* Melander. These are the only species of *Cyrtopogon* seen by the writers that have strong scutellar bristles, but, in addition, the scutellum is clothed with long dense pile, the mesonotum is covered with rather long erect pile, the sides of at least the first three abdominal segments are long pilose, the hind tibiae are not sub-clavate, and the pollinose markings are different. The well defined black occipital bristles and the otherwise more or less bare upper occiput also serve to separate it from *Cyrtopogon*. With the exception of *lutatius* Walker and *anomalus* Cole, the species of *Cyrtopogon* have the occiput densely long pilose without well defined black occipital bristles, and, in the two species mentioned, the bristles are more or less obscured by the pile or hairs on the upper occiput. The genus can be divided further on the characters of the antennae, front, ocellar tubercle, face, and chaetotaxy, but with only a limited number

of species at hand at the present time such a division does not appear to be necessary.

The writers are indebted to the California Academy of Sciences, the Ohio State Museum, the Museum of Comparative Zoology, and Dr. R. H. Painter, for the loan of specimens.

KEY TO THE SPECIES

1. Third antennal joint widest apically, narrowed just before base; style rectangular, but slightly longer than broad; hairs of front and ocellar tubercle in male white, in female black; fore tibiae of male with a dorsal fringe of nearly erect, short, white hairs; anterior crossvein at one-third length of discal cell; length, 4 mm. (California)..... **monrovia,** new species

   Third antennal joint not widest apically, coarctate or of nearly uniform width; anterior crossvein near or beyond middle of discal cell..... 2

2. Third antennal joint long and slender, cylindrical; style short cylindrical, truncate or abruptly narrowed apically, with a short apical spine; wings hyaline..... 3

   Third antennal joint coarctate; style broadest basally and gradually narrowing apically or long and slender, also with an apical spine; wings uniformly light brownish..... 6

3. Front with a distinct tubercle on each side, opposite or slightly above antennae; face at least equal to width of one eye; anterior dorsocentral bristles not strongly developed..... 4

   Front without tubercles; face three-fifths width of one eye; anterior dorsocentral bristles well developed, conspicuous; mystax broadly white on sides, narrowly black down middle and on oral margin; anterior tibiae and metatarsi of male with a crest of erect white hairs above; hypopleural bristles entirely white; length, 6.5 mm. (California), **lestomyiformis,** new species

4. Tubercle on front rather small, to sides of antennae, grayish anteriorly, black behind; at least the second antennal joint with a strong bristle below; face equal to width of one eye..... 5

   Tubercle on front slightly behind antennae, very large, rounded, central portion black, margined with short white pile, "eye-like;" first and second antennal joints without strong bristles below; face one and one-fifth times width of one eye; length, 6.5 mm. (California), **oculatus,** new species

5. Mystax sparse, strong, entirely black; hairs of front, ocellar tubercle, and first two antennal joints black; a strong black bristle below on both first and second antennal joints; third antennal joint twice length of first two joints together; style bare, abruptly narrowed apically; length, 6.5–8 mm. (California)..... **cerussatus** (Osten Sacken)

   Some of bristles on sides and above in mystax white; hairs of front, ocellar tubercle, and first two antennal joints white; a strong black bristle below on second antennal joint only; third antennal joint one and two-thirds times length of first two joints together; style short, white haired, truncate apically; length, 6–8 mm. (California)..... **vanduzeei,** new species

6. Style of antennae slender, plainly two-jointed, about one-half the length of third joint, second joint with two strong bristles below; anterior tibiae with numerous black bristles gradually becoming longer apically; length, 9–10 mm. (California)..... **nigricolor** (Coquillett)

   Style broad basally, not evidently two-jointed, about one-third length of third joint; smaller species..... 7

7. First antennal joint with two strong bristles below; dorsocentral bristles well developed; anterior crossvein before middle of discal cell; fore tibiae of male with a dense layer of recumbent brown hairs above; length, 5–6 mm. (California)..... **minutus,** new species

   First antennal joint without strong bristles; dorsocentral bristles fine, hair-like; anterior crossvein beyond middle of discal cell; male fore tibiae sparse white pilose; length, 5–8 mm. (Idaho, Washington, Oregon, California)..... **atripes,** new species

Nannocyrtopogon cerussatus (Osten Sacken)

Cyrtopogon cerussatus Osten Sacken, West. Dipt., pp. 308–309, 1877.
Cyrtopogon cerussatus Back, Trans. Amer. Ent. Soc., 35: 291–292, 1909.
Cyrtopogon cerussatus Melander, Psyche, 30: 109, 1923.

Back places this among his aberrant species, and Osten Sacken comments on it as follows: "This species differs in many respects from the typical ones of the genus. The broad ocellar tubercle with the deep grooves on each side, the peculiar tubercles near the eyes on each side of the antennae, the row of erect bristles on the lateral stripes of the thoracic dorsum, the subclavate hind tibiae, the gently convex but hardly gibbose face, the conspicuous six bristles on the otherwise bare scutellum, are so many characters which are not found in the other species."

The style of the antennae measures one-fifth the length of the third joint exclusive of the apical bristle, not "perhaps one-tenth" as stated by Osten Sacken; and the third joint is twice the length of the first two joints together.

The species was described from Los Guilucos, Sonoma County, Calif., July 5 (Osten Sacken), type No. 12782 in the Museum of Comparative Zoology, and apparently no specimens have been reported taken since. We are indebted to the Museum of Comparative Zoology for the loan of one of the types, a female.

Nannocyrtopogon vanduzeei, new species

Female: Length 6 mm. Black; face, occiput, and ocellar tubercle densely, front and vertex thinly, grayish yellow pollinose. Mystax black with long white bristles intermixed on sides and upper part; hairs of front, occiput, beard, palpi, and proboscis white; 6 long bristles on the ocellar tubercle, black. Opposite antennae near eyes on each side, a small but well defined tubercle, grayish anteriorly, black posteriorly. First and second antennal joints subequal in length, about as broad as long, white haired, second joint with a long black bristle below; third joint 1⅓ times length of first two joints together, cylindrical, somewhat narrowed on basal one-fourth; style one-sixth length of third joint, covered rather densely with very short, erect, white hairs; truncate apically and bearing a spine at tip.

Thorax black, densely pollinose; central stripes and intermediate stripes bisected by the transverse suture, brown pollinose; humeri, lateral margins, transverse suture, narrow dorso-central stripes, and median bisecting stripe grayish yellow pollinose. Sparse hairs white; bristles black, 2 presuturals, 2 supra-alars, 1 postalar, and 4 dorsocentrals. Scutellum uniformly but thinly grayish pollinose, several fine hairs on the disc near the sides, and 4 strong black marginal bristles. Pleurae and coxae densely grayish brown pollinose, hairs white, hypopleurals long, about 12 on each side.

Abdomen black, subshining; densely gray pollinose as follows: Sides of first segment; sides and an anterior cross-band somewhat removed

from anterior margin on second; the rather broad anterior margins and the posterior corners extending narrowly along sides to anterior margins of third to sixth segments; and on fifth segment the lateral and posterior spots, which are confluent, enclosing a small bare spot near sides anteriorly. Seventh and eighth segments entirely shining; spines at tip brown. Hairs white, rather long on sides of first two segments, short otherwise.

Legs black; hairs white; bristles black excepting 3–4 posteriorly on fore tibiae, and 5–6 posteriorly and 3–4 ventrally on middle tibiae, yellowish; claws black; pulvilli whitish; empodia brown.

Halteres dull brown. Wings hyaline, veins dark brown; anal cell open; anterior crossvein slightly beyond middle of discal cell.

Holotype: Female, Piru, Ventura County, Calif., IV–20–'32 (E. P. Van Duzee); in the California Academy of Sciences.

Paratypes: Two females, same data, in the writers' collections. Most closely related to *cerussatus* O. S.; in addition to the characters given in the key, the tubercles on the sides of the front are considerably smaller than in *cerussatus*.

Named in honor of Mr. E. P. Van Duzee, who has probably collected more fine species of Diptera on the Pacific Coast than any other one person, and wholly incidentally, as the Diptera are quite far removed from his special field of interest.

Nannocyrtopogon oculatus, new species

Male: Length 6.5 mm. Face black, thinly gray pollinose, strongly protuberant, 1⅛ times width of one eye; mystax composed of sparse, black, bristle-like hairs intermixed with finer white hairs. Front broad, 1⅛ times width of face, the sides nearly parallel; on each side and slightly above antennae is a large rounded tubercle each one-third width of front, velvety black centrally and margined with very short whitish pile, appearing "eye-like"; remainder of front, excepting transversally before the ocellar tubercle, which is velvety black, subshining black; hairs on sides white. Ocellar tubercle very broad, nearly two-thirds width of front; narrowly transversally shining black in front, the remainder thickly gray pollinose although appearing largely black at some angles; hairs white, thick and moderately long centrally, with a tuft of 3–4 longer ones on either side. Occiput gray pollinose; beard, fine, white. Cheeks, palpi, and proboscis shining black, the latter with sparse white hairs. Antennae black, the first two joints gray pollinose and with a few short black hairs, both about as long as broad; the third widest basally, narrowed at about basal one-fourth and very gradually widening to before apex, three times as long as first two joints together; style two-jointed, about as wide as apex of third joint, barely distinguishable from it, cylindrical, truncate apically with a minute bristle at apex, about one-sixth length of third joint.

Thorax gray pollinose, a broadly divided central stripe and the intermediate area divided by the transverse suture brown pollinose. Hairs short, white; bristles black, 2 presuturals, 1–2 supra-alars, 1 post-

alar, and about 5 dorsocentrals two of which are anterior. Scutellum densely gray pollinose, with a pair of strong black marginal bristles, and 2–3 fine white hairs on each side. Pleurae and coxae gray pollinose, the propleura and coxae rather thickly white pilose; hypopleural hairs black above, about the lower one-third white, crinkly at tip.

Abdomen black, sides of first segment, anterior and posterior angles of second, and posterior angles of third to sixth segments, and anterior borders of second to seventh segments not reaching sides, gray pollinose. Hairs white, rather long on sides of first two segments, very short and inconspicuous on remainder. Venter gray pollinose and white pilose. Hypopygium small, black, white pilose.

Legs black, hairs white excepting the usual golden hairs on fore and hind tibiae and tarsi; bristles black, a few white ones on anterior tibiae and tarsi, and a brownish row of short ones on middle tibiae posteriorly; claws black; pulvilli white.

Alulae brown, with a white border and fringe. Halteres brown, lower part of knob and upper stem whitish. Wings rather long and narrow, hyaline, veins dark brown, posterior cells, and anal cell narrowly, open; anterior crossvein at five-eighths length of discal cell.

Holotype: Male, Lost Hills, Kern County, IV–11–'32 (Mint Cn., IV–20–'32), Calif. (E. P. Van Duzee); in the California Academy of Sciences.

A most unusual species; the frontal tubercles separate it from all other Asilidae known to the writers.

Nannocyrtopogon monrovia, new species

Male: Length 4 mm. Black; face, front, vertex, and occiput thinly gray pollinose; palpi and proboscis shining. Mystax black; hair-like bristles of front and ocellar tubercle white, a fringe of 6–8 on sides of front and in addition to the shorter ones about 6 longer ones on ocellar tubercle; beard and hairs of palpi and proboscis white. A small tubercle is evident on the front to the sides of the antennae, and near the sides above is an elongate rounded ridge. Antennae black, thinly pollinose; first two joints subequal in length, hairs black, two longer ones below on the first and one strong and one weak one on the second; third joint slightly more than twice length of first two joints together, narrowed at basal one-fourth and widening to apex, truncate apically; style rectangular, about as broad as long, with a short, stiff, blunt spine on inner side near apex, about one-fifth length of third joint.

Mesonotum quite uniformly golden-brown pollinose; humeri, narrow dorsocentral stripes, transverse suture, and postalar callosities gray pollinose. Hairs and bristles black; 3 presuturals, 2 supra-alars, 1 postalar, and 7 dorsocentrals. Scutellum uniformly dull golden pollinose with two erect marginal bristles. Pleurae and coxae uniformly grayish pollinose and white pilose, about 12 crinkly hypopleural hairs, the upper one black and the lower ones white.

Abdomen shining black, sides of first segment, posterior angles of segments 2–5, and median narrow anterior margins of segments 2–5 silvery pollinose, the latter not reaching lateral margins. Bristles

black, 1–2 on sides of first segment and sides of the first two segments white haired, remainder of hairs short, appressed, black. Hypopygium small, black and black pilose, with a tuft of short yellowish hairs at tip.

Legs black, shining; bristles black; claws black; pulvilli dark brown. Femora with short, sparse, silvery hair above and longer straggly hairs below and with a row of bristles on anterior-dorsal surface. Fore tibiae with a short, nearly erect, rather heavy fringe of silvery white hairs on dorsal and posterior surfaces; middle tibiae with short, fine, appressed, silvery hairs; hind tibiae with thick, short, black pile. Fore and middle tarsi silvery pilose on sides and above; hind tarsi thick black pilose on sides and above.

Halteres, lower stem, and most of knob black, upper stem and lower portion of knob paler. Alulae dark brown with a white margin and fringe. Wings uniformly brownish; veins dark brown; anal cell narrowly open; anterior crossvein at one-third length of discal cell.

Female: Length 4 mm. Similar. Front and ocellar tubercle with black hairs; front without the ridge near the sides. Fore tibiae without the fringe of silvery hairs. Ovipositor with 5 short, brown, spatulate spines on either side at tip.

Holotype: Male, Monrovia Canyon, Calif., VIII–3–'30 (C. H. and D. Martin); deposited in the California Academy of Sciences.

Allotype: Female, same data, VII–20–'30; deposited in the California Academy of Sciences.

Paratypes: 14 specimens, both sexes, same data as types taken in July and August, in the writers' collections; and two females from the type locality, VII–30–'30 (T. F. Winburn and R. H. Painter), in Dr. Painter's collection. Two of the female paratypes have three scutellar bristles; the anal cell is closed in some specimens; and some have a short stump of a vein near the base of the anterior branch of the third vein.

Nannocyrtopogon lestomyiformis, new species

Male: Length 6.5 mm. Head black, proboscis shining, palpi and cheeks brownish; and, excepting for a vertical black stripe in middle of face, densely gray pollinose. Face at antennae three-fifths width of one eye, rather protuberant, hairs on oral margin and on central stripe black, otherwise white. Front at vertex about one-third wider than face, white haired; ocellar tubercle about one-half the width of front, short white haired in front and with longer clumps of divergent hairs behind; hairs of upper occiput, beard, palpi, and proboscis white. Antennae brownish black, first two joints gray pollinose, the first slightly longer and narrower than the second, both clothed with rather long white hairs below, shorter above, and the second with a black bristle below; third joint 1¾ length of the first two joints together, slightly larger basally, cylindrical; style two-jointed, nearly one-third the length of the third joint, truncate apically, with a minute bristle.

Thorax gray pollinose, the dorsocentral stripes appearing brownish. Hairs white, rather long; bristles black, 3 presuturals, 2–3 supra-alars, 2–3 postalars, and about 9 dorsocentrals, 5 of which are anterior. Scutellum gray pollinose, with 6 long, black, marginal bristles. Pleurae and coxae gray pollinose, hairs entirely white.

Abdomen brownish black, hairs white, longer on sides of first two segments; gray pollinose markings as usual excepting that the sides of the sixth segment, almost the entire seventh, and the genitalia are gray pollinose.

Legs black, hairs white, fore tibiae and metatarsi with a dense, nearly erect fringe of hairs about equal in length to width of segments; bristles black; claws black, reddish basally; pulvilli light brown.

Alulae brown, with white margin and fringe. Halteres brown. Wings hyaline, veins light brown; anal cell open a distance about equal to length of anterior crossvein; anterior crossvein at five-eighths length of discal cell.

Holotype: Male, San Diego County, Calif., Desert edge, IV–14–'15 (M. C. Van Duzee), in the Hine Collection of the Ohio State Museum.

The general appearance of this species suggests one of the smaller species of *Lestomyia* found in California, specimens of which have been seen bearing the same data; the long anterior dorsocentral bristles possibly are responsible for this illusion.

Nannocyrtopogon minutus, new species

Male: Length 5 mm. Black, face and occiput gray pollinose; front and ocellar tubercle brownish black. Mystax and hairs of front and ocellar tubercle black; beard and hairs of palpi and proboscis white, also a few long whitish hairs behind on ocellar tubercle. Ocellar tubercle about one-half width of front. To the side and slightly above the antennae there is a small rounded swelling covered with very short pile, gray below, brownish above. Antennae black, grayish brown pollinose; first joint narrower and slightly shorter than second, both with short black hairs, the first with two strong bristles below and the second with one; third joint somewhat coarctate, widest at apical two-thirds, not quite twice as long as the first two joints together; style rather broad, slightly tapering apically, with a minute apical bristle, about one-third length of third joint.

Mesonotum dark brown, with lighter brown pollinose markings, humeri largely gray pollinose. Hairs black; bristles black, 2 presuturals, 1 supra-alar, 1 postalar, and about 6 dorsocentrals, of which 3 are anterior. Scutellum brown pollinose, with two strong, black, marginal bristles and a finer one on each side. Pleurae and coxae gray pollinose, somewhat brownish on mesopleura; hairs white; hypopleural hairs long, black.

Abdomen black, pollinose spots on posterior angles small, and anterior bands narrow and only apparent at certain angles, not present on sixth and following segments. Sparse longer hairs on sides of first two segments yellowish; remainder very short, black; about 4 fine black

bristles on sides of first segment. Hypopygium small, shining black, largely with rather long black hairs.

Legs black, bristles black; fore tibiae and metatarsi with a very dense fringe of recumbent brown hairs dorsally, bordered on each side with short black bristles.

Alulae brown, margin dull yellowish. Halteres brown, upper stem yellowish brown. Wings uniformly brownish, veins brown; anal cell nearly open a distance equal to length of anterior crossvein; anterior crossvein very slightly before middle of discal cell.

Female: Length 6 mm. Similar to male. Four strong and two weaker scutellar bristles. Second to fifth abdominal segments with posterior angles and anterior margins pollinose; about five light brown, blunt spines on each side at apex. Anterior tibiae and metatarsi without fringe of hairs and bristles. Anterior crossvein at about two-fifths length of discal cell; fourth posterior cell slightly narrowed.

Holotype: Male, San Antonio Canyon, Calif., VII–27 (Dorothy Martin); deposited in the California Academy of Sciences.

Allotype: Female, with same data, in C. H. Martin's collection.

Paratype: One male, with same data, in J. Wilcox's collection. This specimen has six scutellar bristles.

Nannocyrtopogon atripes, new species

Male: Length 6 mm. Black, face and occiput densely gray pollinose, front and ocellar tubercle densely yellowish gray pollinose; proboscis and palpi shining. Mystax black with a few yellowish hairs intermixed above; front entirely and ocellar tubercle in part clothed with more or less recumbent yellow hairs, ocellar tubercle in addition with 4 black bristles and about 8 erect black hairs; occipital bristles black; beard and hairs of palpi and proboscis white. Antennae black, yellowish gray pollinose; the first joint slightly longer and narrower than the second, yellowish haired; second joint with a very short fine black hair above and a strong black bristle below; third joint slightly coarctate, not quite twice length of first two joints together; style broad basally, rather sharply narrowly apically, with a minute apical spine, style slightly more than one-third length of third joint.

Thorax gray pollinose, a geminate, broad, central stripe, and the intermediate area indistinctly, brown pollinose. Hairs yellow and black; bristles black, 2 presuturals, 1–2 supra-alars, and 1–2 postalars; dorsocentrals short, fine, hair-like. Scutellum gray pollinose, with four strong marginal bristles. Pleurae and coxae gray pollinose and white pilose; hypopleural tuft white, upper two-fifths brownish or black.

Abdomen black, with the usual gray pollinose markings on second to sixth segments; seventh largely gray pollinose. Longer hairs on sides of first two segments white, about five lateral bristles on the first segment, white; remainder of hairs largely short, black. Genitalia black, hairs brown.

Legs black, bristles black; fore and middle tibiae and tarsi with abundant, short, decumbent, grayish white hairs.

Alulae brown, margin and fringe yellowish. Halteres: Base, lower stem, and lower part of knob brown; upper stem and upper part of knob yellowish brown. Wings uniformly pale brownish; veins brown; anal cell open; anterior crossvein at eight-thirteenths length discal cell; third vein branched slightly beyond discal crossvein.

Female: Length 7 mm. Similar. A few black hairs, in addition to the yellowish hairs on the front, shorter than in the male. Abdomen with usual markings on second to fifth segments; sixth and following segments shining black; about 4 or 5 blunt brown spines at apex.

Holotype: Male, Alpha, Long Valley, Idaho, VI–10–'34 (C. H. Martin); deposited in the California Academy of Sciences.

Allotype: Female, same data, in the California Academy of Sciences.

Paratypes: 45 specimens, both sexes, from the following localities: Type locality from V–27 to VII–8–'34 (C. H. and D. Martin), in Martin's collection; Signal Peak, Wash., Summit, elevation 5,111 feet, VII–16–'33 and VI–20–'35 (J. Wilcox), Bull Prairie, Lake County, Oreg., elevation 7,000 feet, VII–21–'32 (D. K. Frewing), Wallowa Lake, Oreg., elevation 4,500–5,500 feet, VII–27–'29 (H. A. Scullen), and Fallen Leaf Lake, Calif., VII–17 (W. J. Chamberlin), in Wilcox's collection; Glenwood, Calif., VII–31–'30 (T. F. Winburn and R. H. Painter), in Dr. Painter's collection; Eagle Ridge, Klamath L., Oreg., V–15–'24 (C. L. Fox), Carrville, Trinity County, Calif., elevation 2,400–2,500 feet, V–25 to VI–5–'34 (E. C. Van Dyke), Fallen Leaf Lake, El Dorado County, Calif., VIII–'31 (O. H. Swezey), Shasta Springs, Calif., VI–11–'20 (C. L. Fox), and Meadow Valley, Plumas County, Calif., elevation 4,000–5,000 feet, VII–6–'24 (E. C. Van Dyke), in the California Academy of Sciences.

The hairs on the front and first antennal joint vary from yellowish to entirely black.

Nannocyrtopogon nigricolor (Coquillett)

Cyrtopogon nigricolor Coquillett, Proc. Ent. Soc. Wash., 6: 183, 1904.
Cyrtopogon nigricolor Back, Trans. Amer. Ent. Soc., 35: 284, 1909.
Cyrtopogon nigricolor Melander, Psyche, 30: 110, 1923.

This species was described from a single female specimen collected in Los Angeles County, Calif., June (D. W. Coquillett), type No. 7956 in the U. S. National Museum. Apparently no other specimens have been taken so the male is described below.

Male: Length 9 mm. Similar to female. First antennal joint clothed with white hairs, long below; style slender, the minute bristle not plainly visible at tip, nearly one-half length of third joint. Ocellar tubercle small, slightly more than one-third width of front at vertex, clothed with fine white hairs, and 5 pairs of black bristle-like hairs.

Mesonotum brown pollinose, a central stripe, transverse suture, humeri, and anteriorly gray pollinose. Sparse, fine hairs largely black; bristles black, 2–3 presuturals, 2 supra-alars, 2 postalars, and 2–3 finer dorsocentrals. Scutellum brown pollinose, 6 strong marginal black bristles and a finer one at the middle. Pleurae and coxae brownish gray pollinose, hairs white; hypopleural hairs black with two or three brownish ones below, crinkly at tip.

Abdomen black, with the usual markings excepting that on the second to fourth segments the anterior bands narrowly reach the lateral margins, on the fifth and sixth segments the pollen on the posterior corners extends forward on the lateral margins to the anterior margins, and the seventh segment is largely pollinose. Hypopygium very small, black, black haired. Sparse long hairs on sides of first two segments whitish; remainder of abdomen largely with very short, sparse, black hairs; 6–7 short, black, lateral bristles on first segment.

Legs black, bristles black, on dorsum of fore tibiae dense and increasing in length apically, forming a rather prominent fringe; fore tarsi also with 2 or 3 long bristles above, decreasing in length on outer joints.

Alulae brownish, with yellowish margin and fringe. Halteres brownish. Wings uniformly tinged with brown; veins dark brown; anal cell very narrowly open in one wing, closed at margin in the other; fourth posterior cell narrowed, the opening equal to slightly more than length of anterior crossvein; anterior crossvein at two-thirds length of discal cell.

Described from a male, taken in Monrovia Canyon, Calif., VII–4–'31 (C. H. and D. Martin), deposited in the U. S. National Museum. Additional specimens, both sexes, with same data and IV–31–'31, in the writers' collections; Sequoia National Park, Calif., Potwish, elevation 3,000–5,000 feet, V–17–'29 (E. C. Van Dyke), in the California Academy of Sciences; and Claremont, Calif. (Baker), in the Ohio State Museum.

EXPLANATION OF PLATE

Antennae of species of *Nannocyrtopogon: atripes* and *minutus* are drawn from the right side, the remainder from the left side, and all are drawn to the same scale.

ATRIPES

NIGRICOLOR

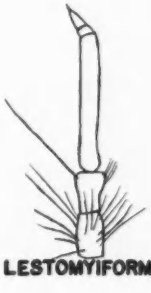
VANDUZEEI

OCULATUS

MONROVIA

CERUSSATUS

MINUTUS


LESTOMYIFORMIS

THE GERMAN INSTITUTE OF ENTOMOLOGY

HERBERT OSBORN

The German Railroads Information office has favored the ANNALS with a statement concerning the 50th Anniversary of the German Institude of Entomology. In this statement from the pen of Doctor Rolf Reissmann we learn that: "The German Institute of Entomology which is celebrating the first half century of its existence this year, is a branch institute of the Kaiser Wilhelm Association, and is located in Gosslar Strasse in the Berlin suburb of Dahlem. Passers-by often ask what is going on within the walls of this fine-looking building.

"The Institute, however, is not exactly a museum. One cannot walk in with a couple of beetles or some other specimen of insect wrapped up in a match-box and look around in the glass show-cases to find out what sort of beetle or insect it is. For such purposes, there is the Zoological Museum in Invaliden-Strasse. On the other hand, those who are well informed know that for the combating of harmful insects, there is always the Reich Biological Institute with its many branches throughout the provinces where a specialty is made of the science of plant protection."

The Institute with an enviable record of service maintains a remarkably fine collection of insects and extensive library and its activities in correspondence, exchanges and bibliographical service make it a clearing house for entomological information for the scientific agencies throughout the world. It is stated that "20,000 articles on Insect Life are written annually."

Following the Paris Congress in 1932, on a cordial invitation from Doctor Walter Horn, a party consisting of Doctor P. W. Claassen, Professor J. J. Davis, Doctor Marcovitch, Mrs. Davis, Mrs. Osborn and the writer spent a most enjoyable day at the Institute, guests of Doctor and Mrs. Horn, and we formed a very favorable opinion of the facilities available there.

The two Directors at present are Dr. Walter Horn and Dr. Sachtlaben.

BIOGRAPHICAL SKETCHES OF OFFICERS OF THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

In a recent issue of the Proceedings of the Entomological Society of Washington (Vol. 38 (6): 99–145, June, 1936) there appears an article by J. S. Wade entitled "The Officers of Our Society for Fifty Years," which gives brief biographical data concerning seventy-two Washington entomologists who have held office in that society during its first fifty years of existence. We call attention to the article in our belief that records of this kind help build a picture of American entomological work as a whole, that such records give the individual worker greater assurance of the strength of his profession.—C. H. K.

PRELIMINARY STUDIES IN THE NORTH AMERICAN PHORACANTHINI AND SPHAERIONINI

(Coleoptera, Cerambycidae)

E. Gorton Linsley,
University of California

The North American components of the tribes Phoracanthini and Sphaerionini have probably been subject to greater confusion than any other groups of Cerambycidae. The writings of Lacordaire, LeConte, Horn, Bates, and Casey contain striking differences of opinion, and in almost any large collection one can find a great many species masquerading under incorrect names. Although additional material has done much to clear up this confusion, it is felt that our knowledge of these groups is still too imperfect to warrant a complete revision at this time. Such a revision can only be undertaken when the fauna of Mexico and tropical America has been more thoroughly collected. It is the object of the present paper merely to propose a tentative arrangement of the genera and to make known such new species and changes as seem advisable at this time. Appreciation is expressed to Dr. E. C. Van Dyke, Mr. Ralph Hopping, Mr. J. N. Knull, and Mr. F. H. Parker, for the loan of material, and to Mr. W. S. Fisher for the comparison of several species with types in the collection of the United States National Museum.

Phoracanthini

Lacordaire[1] separated the Phoracanthini from the Sphaerionini upon the structure of the anterior and intermediate coxal cavities and the uncarinated antennae and tibiae. This distinction has not proved entirely satisfactory. In the typical Phoracanthini the anterior coxal cavities are rounded and closed externally and in the typical Sphaerionini they are angulated externally, but this character shows some variation in both groups. The intermediate coxal cavities may be either open or closed in closely related species of the same genus, making separation on this basis impossible. The most reliable character,

[1]Lacordaire, 1869, Gen. Col., 8: 312.

therefore, appears to be the uncarinated antennae and tibiae, but even this character breaks down in a few species of *Elaphidion*. In general, however, the Phoracanthini may be distinguished by the fact that the antennae and tibiae are not carinated (with the exception noted above) and the antennae are ~~never~~ serrated or flattened apically.

The problem of segregation of genera has proved to be particularly difficult. The tribe undeniably falls into a number of superficial groups which may be quickly recognized by their facies, yet constant characters for their separation have thus far eluded the systematist. It is hoped that the table below will serve for the present to distinguish some of the more obvious groups. The writer has proposed only such new genera as seemed imperative, and there remain many forms whose generic status is still unsatisfactory.

TABLE OF GENERA OF PHORACANTHINI OF AMERICA NORTH OF MEXICO

A. Large, stout species; metathoracic episterna narrowed behind.
  B. Antennal spines prominent; antennal segments with distinct areas of sensitive punctulation; elytral apices spinose.....**Romaleum**
  BB. Antennal spines small; segments of antennae excavated beneath; elytral apices not spinose.....**Eustromula**
AA. Smaller, more slender species; metathoracic episterna parallel-sided.
  B. Pronotal sculpture variable, but never consisting of longitudinal anastomosing carinulae.
    C. Antennal segments spinose at apex.
      D. Body without long, flying hairs; pronotum usually with a median polished vitta; elytral pubescence mottled, consisting of both suberect dark hairs and recumbent cinereous pile.
        E. Antennal spines prominent; elytral apices spinose; femora often spined at apex.....**Elaphidion**
      EE. Antennal spines small; elytra and femora unarmed at apex. **Anelaphus**
      DD. Body clothed with long, flying hairs; pronotum without a polished median vitta, sculpturing alveolate; elytral pubescence unicolorous, consisting of suberect hairs only.
        E. Antennal spines prominent; elytra and femora unarmed at apex.....**Anopliomorpha**
    CC. Antennal segments feebly dentate at apex, not spinose.
      D. Body without long, flying hairs; pronotum without a median polished vitta; elytral pubesecence usually unicolorous, sometimes mixed with recumbent pile.
        E. Elytra and femora unarmed at apex.....**Anoplium**
  BB. Pronotal sculpture consisting of a network of longitudinal anastomosing carinulae.
    C. Antennal segments spinose at apex.
      D. Body without flying hairs; elytra fasciate, the fascae formed of recumbent white pile.
        E. Antennal spines short; elytra and femora unarmed at apex. **Elaphidionopsis**

Genus **Romaleum** White

Romaleum White, 1855, Cat. Col. Brit. Mus., 8: 309.
Thersalus Pascoe, 1866, Journ. Ent., 2: 372.
Hypermallus Lacordaire, 1869, Gen. Col., 8: 302.

This genus is characterized by its large size, robust form, posteriorly narrowed metathoracic episterna, and the presence of sensitive areas on the ventral surface of the antennal segments. The genotype is *R. operarium* White (a synonym of *Cerambyx hispicorne* Linn.), not *Cerambyx atomarius* Drury as stated by Casey.[2] *Hypermallus* is identical with *Romaleum*, the type having been designated by Lacordaire as *Cerambyx pulverulentus* Degeer (a synonym of *C. atomarius* Drury). The selection by Casey (l. c., p. 292) of *Cerambyx villosus* Fabr. as the type of *Hypermallus* is, of course, quite untenable.

Genotype: *Romaleum operarium* White.

Seven species are known, all from North America.

Genus **Eustromula** Cockerell

Eustromula Cockerell, 1906, Ent. News, 17: 242.
Eustroma LeConte, 1873, Smiths. Misc. Coll., 11: 186.
LeConte and Horn, 1883, Class. Col., p. 288.
Horn, 1885, Ent. Am., 1: 133.

Eustromula differs from *Romaleum* mainly in the shorter antennal spines, in having the intermediate antennal segments excavated beneath, and in the unarmed elytral apices. Only two species are known, one from southwestern United States and northern Mexico, the other from the Tres Marias Islands (off the west coast of Mexico). *Anoplium huachucae* Casey[3] is identical with *Eustromula validum* LeConte.

Genotype: *Elaphidion validum* LeConte.

Genus **Elaphidion** Serville

Elaphidion Serville, 1834, Ann. Soc. Ent. Fr., 3: 66.
LeConte, 1850, Journ. Acad. Phil., 2: 52.
Lacordaire, 1869, Gen. Col., 8: 300.
LeConte and Horn, 1883, Class. Col., p. 287.
Leng, 1884, Bull. Brook. Ent. Soc., 7: 115.
Casey, 1912, Mem. Col., 3: 29.
Centrocerum Thomson, 1864, Syst. Ceramb., p. 244.
Cyclioplеurus Hope, 1835, Trans. Zool. Soc. Lond., 1: 107.
Hypermallus Casey (nec Lacordaire), 1912, Mem. Col., 3: 292.

This genus is closely related to *Romaleum*, differing primarily in the smaller size of the species, the parallel-sided metathoracic

[2]Casey, T. L., 1912, Mem. Col. 3: 291.
[3]Casey, T. L., 1924, Mem. Col., 11: 245.

episterna, and the antennae usually without sensitive spaces. In a few species the antennae are carinate as in *Aneflus*. Casey (l. c.) widely separates *Elaphidion* and *Hypermallus* (nec Lacordaire), stating that "the remarkable prosternal characters and very long spine of the antennae show that it (*Elaphidion*) is not closely related to *Hypermallus*, in spite of a certain facies in common." In the series at hand, however, both of these characters grade so imperceptably from one group to another, that distinction on this basis is impossible.

Genotype: *Cerambyx irroratus* Linn.

Elaphidion compactum (Casey)

This species is quite distinct from *E. incertum* Newman, differing in the short, stout, compact form, more transverse prothorax, coarser, closer pronotal punctation, and unarmed femora. Also, in an example taken by the writer along the Devil's River, near Del Rio, Texas, the pubescence is much more dense than in typical *incertum*.

Elaphidion incertum (Newman)

This species also occurs in Texas, where I have taken it in small series at light, near Uvalde, July, 1930.

Elaphidion arizonensis (Casey)

E. arizonensis is one of the largest species of *Elaphidion* found within the borders of the United States. The sexual differences in pronotal sculpturing are but little less pronounced than in *Romaleum*. The pronotal punctation in the female is very coarse, close, cribrate, and the median polished vitta irregular in shape, and in the male the punctures are more shallow, less dense, and somewhat rugose, with the median polished vitta narrow, short, and linear. The outer antennal segments have *Aneflus*-like carinae.

In the Horn and other U. S. collections, this species is labelled *Hypermallus grisescens* Bates, but I can find little in Bates' original description to warrant such a determination. Bates states that his species is very closely allied to *inermis* Newman and *truncatus* Leconte, and his description of sexual differences in pronotal, sculpture does not apply to the species at hand. *H. grisescens* Bates undoubtedly belongs in the following genus.

E. arizonensis is not uncommon in the Huachuca Mts. and near Nogales, Arizona. It also occurs in northern Mexico.

Genus **Anelaphus** Linsley, new genus

Moderately elongate; elytral pubescence variegated, consisting of both suberect, dark hairs, and recumbent white pile. Head rather flat between the antennae, maxillary palpi longer than labial palpi, last segment triangular; eyes deeply emargi-

nate, coarsely granulate; antennae as long or slightly longer than the body (♂), shorter than the body (♀), not carinate, apical spines small, scape reverse cone-shaped, third and fifth segments subequal in length, fourth segment shorter, remaining segments decreasing gradually in length toward apex. Pronotum rounded at the sides, usually with a polished, median, longitudinal vitta. Elytra moderately elongate, subparallel; apices rounded or truncate, never spinose. Legs short; femora slender, unarmed at apex; tibiae not carinate. Prosternum narrow between the coxae; anterior coxal cavities rounded externally, closed.

Genotype: *Elaphidion spurcum* LeConte.

Anelaphus includes part of the *Anoplium* of authors, but the latter genus is here restricted to those species with unarmed antennae, uniform pubescence, and without a median pronotal vitta in either sex. It differs from *Elaphidion* in the feebly spinose antennae which are only as long or slightly longer than the body in the male, and the unarmed femora and elytral apices. In addition to the type species, *Anelaphus* will include *Elaphidion truncatum* Lec., *E. niveivestitum* Schffr., *E. brevidens* Schffr., *Anoplium quadricollis* Casey, *E. inerme* Newman, and others.

Anelaphus quadricollis (Casey)

One example which I have referred to this species (Van Horn, Texas, V-23-32) is smaller than the type, with the elytral apices more rounded and the pronotum less parallel-sided. However, the antennal spines are obsolete and in most of its characters this Texan example agrees better with *quadricollis* Casey than with *truncatus* LeConte.

Anelaphus albofasciatus (Linell)

Anoplium linelli Casey, 1924, Mem. Col., 11: 246.

A study of the type series of *A. linelli* as well as examples from Arizona in my own collection has convinced me that this species is identical with *albofasciatum* Linell. In spite of Casey's statement to the contrary I find that his series agrees closely in size and color with typical *albofasciatus* from southern California, and as regards "the feeble lateral thoracic tubercle" and the "shorter basal joint of the hind tarsi," I can find no impressive difference in this respect.

Genus **Anopliomorpha** Linsley, new genus

Small, slender, subparallel, clothed with long, flying hairs. Head flat between the antennae; eyes coarsely granulated; antennae slender, as long as or slightly longer than the body (♂), shorter than the body (♀), antennal spines prominent.

Pronotum rounded at the sides; punctation coarse, alveolate; disk without trace of a median polished vitta. Scutellum rounded behind, densely pubescent. Elytra subparallel, rather coarsely punctured; apices rounded, not spinose. Legs slender, clothed with flying hairs; femora unarmed at apex.

Genotype: *Periboeum reticolle* Bates.

This genus is very distinct in the long, flying hairs on the legs, antennae, and entire upper surface, and the peculiar alveolate sculpture of the pronotum. The antennal spines are very prominent, but the femora and elytral apices are unarmed. The genus will include *Anoplium rinconium* Casey and several undescribed species from Mexico.

Anopliomorpha reticollis (Bates)

Although this species has been recorded from Arizona, I have not seen it from that region. All examples so labelled which have been studied by the writer have proved to be *A. rinconium* Casey, *A. nanulum* Casey, or some other species. Typical *A. reticollis* occurs in northern and western Mexico.

Anopliomorpha rinconium (Casey)

(Pl. I, Fig. 3)

This species is closely related to the preceding but is more slender, with a more elongated prothorax, distinctly larger pronotal punctures, and longer, coarser, flying hairs covering the entire body. In addition to the type specimen, I have seen examples from Patagonia, Nogales, and Mt. Washington, all in Arizona.

Genus **Anoplium** Haldeman

Anoplium Haldeman, 1847, Trans. Am. Phil. Soc. (2), 10: 34.
Lacordaire, 1869, Gen. Col., 8: 355.
LeConte and Horn, 1883, Class. Col., p. 288.
Casey, 1912, Mem. Col., 3: 292.

In this genus the antennal segments are feebly dentate at the apex but not spinose, the pronotum without a median polished vitta, and the elytral pubescence uniform. Lacordaire (l. c.) places it in the Callidiopini because of the absence of antennal spines, but its affinities seem rather with the Phoracanthini where it was placed by LeConte. The genus includes *Anoplium nanulum* Casey, *A. tuckeri* Casey, *A. hoferi* Knull, *Elaphidion simile* Schffr., and several Mexican species. I have also temporarily included *Elaphidion moestum* LeConte and *Anoplium duncani* Knull, two very abberant forms which seem more closely related to *Anoplium* than any other described genus.

Genotype: *Anoplium unicolor* Haldeman.

The name *cinerascens* proposed by LeConte for the above species is unnecessary and must revert to synonymy.

Anoplium nanulum Casey

This species is closely allied to *A. tuckeri* Casey and differs mainly in its smaller size and paler coloration. In addition to the type series, I have seen *tuckeri* from Patagonia, Globe, and Tucson in Arizona, and from Alpine and Falfurias in Texas. All my examples of *nanulum* are from the Chiracahua Mts., Ariz. I am inclined to believe that *nanulum* and *tuckeri* may eventually prove to be the same species.

Anoplium nanum (Fabricius)

Anoplium subtropicum Casey, 1924, Mem. Col., 11: 245.

Casey's type of *A. subtropicum* differs in no appreciable way from typical examples of *A. nanum* from Cuba and Florida.

Genus **Elaphidionopsis** Linsley, new genus

Small, parallel-sided, clothed with short, suberect hairs intermixed with longer, erect setae. Head rather flat between the antennae, surface with numerous fine, longitudinal carinulae; eyes coarsely granulated; antennae slightly longer than the body (♀), scape not stout, fourth segment shorter than third or fifth, segments three to five with a short spine at the apex. Prothorax rounded at the sides; discal surface with a network of fine, longitudinal, anastomosing carinulae. Scutellum transverse. Elytra subparallel, fasciate, the fasciae composed of recumbent, white pubescence; apices truncate, not spinose. Legs slender; femora feebly clavate, unarmed at the apex.

Genotype: *E. fasciatipennis* n. sp.

This genus is easily recognized by the sculpturing of the pronotum, which consists of a network of fine, longitudinal, anastomosing carinulae. The antennal spines are short, the pubescence of a double type, and the femora and elytral apices unarmed. The following is the only known species:

Elaphidionopsis fasciatipennis Linsley, new species

(Pl. I, Fig. 1)

Reddish brown, head and prothorax rufo-piceous; surface sparsely clothed with short, suberect hairs, intermixed with longer, scattered, erect setae. Head and pronotum sparsely pubescent. Scutellum densely clothed with white, recumbent pile. Elytra with an irregular, transverse, ante-median, white fascia and a similar fascia at apical one-fourth, both formed of patches of dense, white, recumbent pubescence; punctation rather coarse and moderately dense, becoming sparser and finer apically.

Body beneath shining, sparsely punctured and pubescent. Length 9.3 mm.; breadth 1.9 mm.

Holotype female (No. 3999 C. A. S. Ent.) taken at light on the Devil's River, near Del Rio, Texas, June 16, 1932, by the writer.

In addition to the generic characters, this species may be easily known by the reddish brown color and the disposition of the elytral fasciae.

Sphaerionini

The Sphaerionini are distinguished from the Phoracanthini by the presence of carinae on the antennae or tibiae (or both) and the antennae sometimes flattened apically or serrated. The group is dominantly neotropical with only a few genera in America north of Mexico.

TABLE OF GENERA OF SPHAERIONINI OF AMERICA NORTH OF MEXICO

A. Pronotum dull, densely punctured and pubescent.
  B. Elytra without long, erect setae; punctation moderately dense.
    C. Antennae serrated, segments with an external process, not spinose.
      D. Antennae twelve-segmented in the male, eleven-segmented in the female; elytral apices bispinose in the male, unarmed in the female.....**Axestinus**
    CC. Antennae filiform or flattened apically, usually spined at apex of segments.
      D. Antennae with outer segments flattened, carinate; elytral apices always spinose; large species, usually more than 20 mm. in length.....**Aneflus**
      DD. Antennae slender, carinae when present usually basal; elytral apices variable; smaller species, usually less than 20 mm. in length.
        E. Body without flying hairs; spine of third antennal segment moderate or absent; antennal segments carinate....**Aneflomorpha**
        EE. Body clothed with long, flying hairs; spine of third antennal segment long; antennal carinae obsolete.....**Anepsyra**
  BB. Elytra sparsely clothed with long, erect setae; punctation coarse, sparse.
    C. Antennae slender, carinae obsolete; pronotum flattened, disk with three smooth vittae.
      D. Elytral apices unispinose.....**Stenelaphus**
AA. Pronotum polished, shining, sparsely punctured and feebly pubescent.
  B. Eyes finely granulated; prothorax wedge-shaped; spine of third antennal segment always moderate in length.....**Stenosphenus**
  BB. Eyes coarsely granulated; prothorax cylindrical; spine of third antennal segment often very long.....**Psyrassa**

Genus **Axestinus** LeConte

Axestinus LeConte, 1873, Smiths. Misc. Coll., 11: 177.
Proteinidium Bates, 1892, Trans. Ent. Soc. Lond., p. 149.

The species upon which this genus is founded has long been misunderstood by American authors. Leng[4] in his synopses of Cerambycidae, gives a figure of an *Aneflus* (apparently *A. sonoranus* Casey) under the name *Axestinus obscurus*.

[4]Leng, C. W., 1885, Ent. Amer. I, Pl. II, Fig. 27.

From the remarks of Mr. Schaeffer,[5] it would appear that he had made the same mistake in determination. However, an examination of the type has shown that the true *Axestinus obscurus* is quite a different species. It is uniformly reddish brown in color, sparsely clothed with pale, recumbent pubescence and has distinctly serrate, non-spinose antennal segments. The genus *Proteinidium* Bates was founded on the female of *Axestinus*. The two sexes differ as follows:

Male: Antennae twelve-segmented; elytral apices strongly bispinose; fifth ventral abdominal segment transverse, emarginate at apex.

Female: Antennae eleven-segmented; elytral apices rounded, without trace of spines; fifth ventral abdominal segment longer than broad, rounded at the apex.

Genotype: *Axestinus obscurus* LeConte. (Pl. I, Figs. 4, 4a).

Genus **Aneflus** LeConte

Aneflus LeConte, 1873, Smiths. Misc. Coll., 11: 185.
LeConte and Horn, 1883, Class. Col. N. Am., p. 287.
Leng, 1885, Ent. Amer., 1: 34.
Horn, 1885, l. c. 31.
Casey, 1912, Mem. Col., 3: 291.

This genus is composed of moderately large species with the outer antennal segments flattened and carinate and the elytral apices bispinose (rarely trispinose). Eight species are known, all from southwestern United States and Mexico.

Genotype: *Elaphidion protensum* LeConte.

Key to the Species of Aneflus

Pronotum distinctly longer than broad 1
Pronotum as broad as or broader than long 5
1. Elytral pubescence irregular, conspicuous 2
Elytral pubescence uniform, sparse, inconspicuous 4
2. Elytral costae not evident 3
Elytra with three polished longitudinal costae; antennae shorter than the body in both sexes; pronotum feebly sculptured; 22–26 mm. Texas, Arizona, New Mexico ..... **sonoranus**
3. Antennae not longer than the body in either sex, spines small; elytral pubescence cinereous with three rows of small, round, denuded spots; pronotal disk bituberculate; 22–24 mm. Lower California, Arizona, New Mexico, Texas ..... **prolixus**
Antennae distinctly longer than the body in the male, spines prominent; pubescence gray and white; pronotal disk vaguely quadrituberculate; 25–31 mm. California, Arizona, New Mexico, Texas, Mexico: Sonora, **protensus**
4. Pronotum rounded at the sides, disk with a polished median callosity; 30 mm. Mexico: Vera Cruz ..... **fulvipennis**
Pronotum cylindrical, parallel-sided, disk without a median callosity. 30 mm. Mexico: Vera Cruz ..... **cylindricollis**

[5] Schaeffer, Chas., 1908, Bull. Brook. Inst., 1: 335.

5. Brownish piceous; pubescence uniform, sparse, very inconspicuous; elytral spines short; 27–30 mm. Southern California, Arizona.....**calvatus**
Reddish brown; pubescence irregular, cinereous, conspicuous; elytral spines very prominent..... 6
6. Antennal scape strongly emarginate on under side at apex; pubescence fulvous; 29–31 mm. Mexico: Sinaloa.....**basicornis**
Antennal scape feebly emarginate at apex; pubescence white; 30–32 mm. Mexico: Mexico and Morelos.....**rugicollis**

(1) **Aneflus sonoranus** Casey

(Pl. I, Figs. 5, 5a)

Aneflus sonoranus Casey, 1924, Mem. Col., 11: 241.
Axestinus obscurus Leng, 1885, Ent. Amer. I, Pl. II, Fig. 27.
Axestinus obscurus Schaeffer, 1908, Bull. Brook. Inst., 1: 335.

This species is one of the most aberrant members of the genus, differing in the vittate arrangement of the elytral pubescence and feebly sculptured pronotum. Some of its characters are quite variable and the elytral apices may be either bispinose or trispinose[6] and the antennae of the male either eleven-segmented with the last segment appendiculate or twelve-segmented with the twelfth segment free. *A. sonoranus* somewhat resembles *Aneflomorpha levetti* Casey and is often confused with that species. The latter is much smaller and narrower, however, with the antennae slender throughout and longer than the body in the male. *A. sonoranus* occurs in Arizona, New Mexico, and Texas, and is frequently captured at light.

(2) **Aneflus prolixus** LeConte

Aneflus prolixus LeConte, 1863, Smiths. Misc. Coll., p. 203.
Aneflus prolixus Leng, 1885, Ent. Amer., 1: 35.
Aneflus prolixus Horn, 1885, l. c., p. 132.
Aneflus fisheri Knull, 1934, Ohio Jour. Sci., 34: 335.

This species is easily recognizable by the three rows of small, round, denuded areas on the elytra and feeble antennal spines. The pronotal pubescence is rather more dense than in the following species and its arrangement gives the impression of a transverse elevated ridge. At the request of Mr. J. N. Knull, a paratype of *A. fisheri* was compared with the type of *A. prolixus* by Mr. P. J. Darlington, and the two found to be identical. The species was described from Lower California and also occurs in Arizona, New Mexico, and Texas.

(3) **Aneflus protensus** (LeConte)

Elaphidion protensum LeConte, 1858, Proc. Acad. Phil., p. 82.
Aneflus protensus Leng, 1885, Ent. Amer., 1: 34, Pl. III, Fig. 5.
Aneflus protensus Horn, l. c., 1: 132.
Aneflus cochisensis Casey, 1912, Mem. Col., 3: 296.

This species is slightly larger than the preceding and differ in the gray and white pubescence without denuded areas, the more prominent antennal spines, and quadrituberculate pronotum. The type of *A. cochisensis* Casey agrees with typical examples of *A. protensus* in every respect except that the elytral spines are a little shorter than usual.

[6]This same variation occurs in some *Stenosphenus*.

A. protensus is frequently attracted to light in Arizona, Texas, So. California, and Sonora, Mexico.

(4) **Aneflus fulvipennis** Bates

Aneflus (?) *fulvipennis* Bates, 1892, Trans. Ent. Soc. Lond., p. 148, Pl. 5, Fig. 2.

This and the following species I have not seen. From Bates' description and figure, *A. fulvipennis* appears to be very distinct in the fulvotestaceous elytra, sparse and inconspicuous pubescence, and prominent pronotal callosities. It was described from Rinconada in Vera Cruz, Mexico.

(5) **Aneflus cylindricollis** Bates

Aneflus cylindricollis Bates, 1892, Trans. Ent. Soc. Lond., p. 147, Pl. 5, Fig. 1.

A. cylindricollis is very suggestive of *Hypermallus longissimus* Bates, but the latter species has non-carinate antennae and densely pubescent elytra. From all other species of *Aneflus*, *cylindricollis* may be distinguished by the elongate, parallel-sided, cylindrical prothorax.

(6) **Aneflus calvatus** Horn

Aneflus calvatus Horn, 1885, Ent. Amer., 1: 132.

This species differs from all other described members of the genus in the very convex form of the female. The pubescence is very sparse and inconspicuous and the elytral spines short. In the male there is often a short tooth in the emargination between the apical elytral spines. Horn (l.c) states that spines occur on antennal segments three to six. In all of the examples before me there is also a distinct spine on the seventh segment. *A. calvatus* is found in Arizona and southern California.

(7) **Aneflus basicornis** Linsley, new species

(Pl. I, Fig. 9)

Elongate, subcylindrical, reddish brown, clothed with short, recumbent, fulvous pubescence. Head rather coarsely punctured, clothed with recumbent pubescence; gula acutely impressed on each side at base; antennae attaining apical one-sixth of elytra (♂), scape subcylindrical, apex on underside strongly emarginate, exposing base of second segment; segments three to seven spinose at apex, six to eleven flattened, carinate; eleventh segment feebly appendiculate. Pronotum about as broad as long, subquadrate, coarsely and somewhat rugosely punctured except for a polished, median longitudinal vitta. Scutellum densely clothed with recumbent white pubescence. Elytra more than three times as long as broad, subparallel; punctation rather coarse at base, becoming finer, sparser apically; pubescence short, recumbent, fulvous, somewhat irregular; apices prominently bispinose. Ventral surface finely punctured, abdomen clothed with slightly longer, suberect, fulvous pubescence. Fifth ventral abdominal segment transverse, emarginate at apex (♂). Length 29–31 mm.; breadth 7–7.5 mm.

Holotype male, (No. 4000, C. A. S. Ent.) and one paratype male, from Venedio, Sinaloa, Mexico, July 27, 1918, J. A.

Kusche (in collection of Dr. E. C. Van Dyke). Additional paratypes, taken at the same time and place, are in the collection of the United States National Museum.

This species differs from all other known species in the genus in the peculiar structure of the antennal scape which is strongly emarginate at the apex on the under side exposing the basal portion of the second antennal segment (see Fig. 9).

(8) **Aneflus rugicollis** Linsley

(Pl. I, Fig. 8)

Aneflus rugicollis Linsley, 1935, Trans. Amer. Ent. Soc., 61: 74.

A. rugicollis differs from all other known species except the preceding in the very transverse, strongly rugose pronotum. From *basicornis*, however, it may be readily separated by the feebly emarginate antennal scape and flaky white pubescence. The species occurs in Mexico, Morelos, and Colima.

Genus **Aneflomorpha** Casey

Aneflomorpha Casey, 1912, Mem. Col., 3: 291.

Aneflomorpha is allied to the preceding genus, differing in the short, recumbent pubescence without flying hairs, short or obsolete spine on the third antennal segment, and basal antennal segments sometimes carinate. The genus is a large one, with many species in southwestern United States and northern Mexico.

Genotype: *E. subpubescens* LeConte.

Aneflomorpha lineare (LeConte)

This species is one of the smallest in the genus. It is readily known by the rufo-testaceous color, feebly spinose antennae, and emarginate but not spinose elytral apices. It occurs in southern California.

Aneflomorpha duncani Linsley, new species

Elongate, piceous, sparsely clothed with fine, white, recumbent pubescence. Head coarsely, closely punctured; antennae slightly longer than the body (♂), shorter than the body (♀), ciliate on the inner side, segments three to five spinose at apex, three to seven carinate; scape short, stout, coarsely punctured, fourth segment shorter than third or fifth, spine on third segment about one-third as long as the segment, spine on fourth segment one-half as long as the spine on third, and spine on fifth very short. Pronotum slightly longer than broad, sides rounded, base constricted; disk coarsely, closely punctured except for a narrow polished vitta (♂), uniformly closely punctured (♀). Scutellum transverse, clothed with long, recumbent pubescence. Elytra at base one-fourth wider than pronotum, subparallel, four times as long as broad; base coarsely, moderately closely punctured, the punctures becoming smaller and sparser apically; apices bispinose. Legs slender; femora

coarsely punctured, clothed with suberect pale pubescence. Abdomen black, coarsely punctured, clothed with suberect, pale hairs. Length 16.5 mm.; breadth 3 mm.

Holotype male (No. 4001, C. A. S. Ent.), allotype female (No. 4002, C. A. S. Ent.), and several paratypes taken at Globe, Arizona, by Mr. D. K. Duncan.

This species differs from all other described species in the genus by its dark, piceous color and rounded, basally constricted pronotum. The elytra at base are about one-fourth wider than the pronotum, antennal segments three to five spinose and three to seven carinate, and the elytral apices bispinose.

Aneflomorpha texana Linsley, new species

Elongate, brownish testaceous, shining, sparsely clothed with short, fine, subrecumbent pupescence. Head coarsely, closely punctured; antennae slightly longer than the body (♂), ciliate within, segments three to five spinose at apex, three to seven carinate; scape moderately stout, coarsely punctured, fourth segment shorter than third or fifth. Pronotum slightly longer than broad, feebly constricted at base and apex; disk closely, coarsely punctured except for a smooth median vitta (♂). Elytra at base one-third wider than pronotum, subparallel, punctation less coarse and less dense than on pronotum; apices feebly emarginate, not spinose, only the inner angle dentiform. Legs slender; femora sparsely clothed with suberect, pale hairs. Abdomen finely punctured, clothed with suberect pale pubescence. Length 15 mm.; breadth 2.75 mm.

Holotype male (No. 4003, C. A. S. Ent.), and one paratype (Van Dyke collection, Calif. Acad. Sciences) from Glen Ranch, Alpine, Texas, O. C. Poling, collector. A second paratype, from the same locality, July 15–30, 1926, is in the collection of the United States National Museum.

A. texana is closely allied to *A. seminuda* Casey and I would be inclined to consider it the male of that species were it not that the antennae are distinctly carinate. In no other species before me is the presence or absence of antennal carinae a sexual character. In addition to the antennal carinae, *texana* differs from *seminuda* in the shape of the elytral apices which are feebly emarginate with only the inner angle dentiform.

Aneflomorpha elongata Linsley, new species

(Pl. I, Fig. 6)

Elongate, slender, reddish brown, sparsely clothed with subrecumbent, pale hairs. Head finely, closely punctured; eyes large, very convex; antennae slender, shorter than the body (♀), segments three to five spinose, three to six densely ciliate, three to nine carinate; scape slender, subcylindrical, moderately coarsely punctured; fourth segment shorter than third or fifth. Pronotum a little longer than broad, slightly con-

stricted at base and apex, sides feebly tuberculate at middle, disk very coarsely, rugosely punctured. Scutellum finely, closely punctured, sparsely pubescent. Elytra four times as long as broad, parallel-sided; punctation coarse at base, finer, sparser apically; pubescence short, sparse, suberect; apices feebly emarginate, not spinose, only the inner angle dentiform. Legs slender; femora sparsely clothed with pale, suberect hairs. Body beneath shallowly, unequally punctured, sparsely clothed with subrecumbent, pale, pubescence. Length 14 mm.; breadth 2.5 mm.

Holotype female (No. 4004, C. A. S. Ent.), taken in Santa Ana Canyon, Orange County, California, July 15, 1930, by Mr. K. D. Sloop, who very kindly presented the specimen to me.

This species is easily known by the very much elongated, slender, form, coarsely, rugosely punctured pronotum which is feebly tuberculate at the sides, and by the shape of the elytral apices which are slightly emarginate with only the inner angle dentiform. In this last character, *elongata* agrees with *texana* Linsley.

Aneflomorpha imbellis Casey

A. imbellis is very distinct by reason of its short, stout form (with the elytra less than three times as long as broad), coarsely punctured pronotum which is two-thirds as wide as the elytra at base, unarmed antennae, and unispinose elytral apices which are rounded externally. I have examples from Santa Ana Canyon, Orange Co., Calif. (K. D. Sloop collector) and Globe, Arizona, (D. K. Duncan collector).

Aneflomorpha unispinosa Casey

This species agrees with the preceding in the unispinose elytra, but is much more elongate (with the elytra four times as long as broad), with a narrower more cylindrical pronotum which is only one-half as wide as the elytra at base, and with feebly armed antennae. The pubescence is fine, sparse, subrecumbent, without any long erect hairs intermixed, the punctation coarse, reticulate, and the antennal segments three to eight carinate. *A. unispinosa* occurs in the Chiricahua and Huachuca Mts., Arizona, as well as in various parts of northern Mexico.

Aneflomorpha parkeri Knull

A. parkeri agrees with *imbellis* and *unispinosa* in the unispinose apices of the elytra, but differs in that the pubescence of the elytra consists of recumbent and erect hairs intermixed. The type was from the Pinal Mountains, Arizona.

Aneflomorpha rectilinea Casey

This species is very elongate and slender with a long spine on the third antennal segment (much as in *Anepsyra*), a moderate spine on the fourth and a short spine on the fifth segment. The elytral apices are emarginate and bispinose, with the external spine longer. My examples are all from the Chiricahua Mts., Arizona.

Aneflomorpha levetti Casey

This species was shuffled about by Casey between *Aneflomorpha* and *Aneflus*, but because of its slender form, filiform and not flattened antennae, it seems best placed in *Aneflomorpha*. *A. levetti* may be easily known by its large size (21–23 mm.), cylindrical, coarsely punctured pronotum, and polished elytral costae. It occurs in southern Arizona (Oracle and Huachuca Mts.).

Aneflomorpha arizonica Linsley, new species

Elongate, slender, reddish brown, shining, sparsely clothed with subrecumbent, white, pile. Head rugosely punctured; antennae slender, filiform, slightly longer than the body (♂), about three-fourths as long as the body (♀), segments three to five with a short spine at apex, three to six ciliate within, and three to seven carinate. Pronotum cylindrical, longer than broad, very coarsely punctured except for a narrow median vitta. Scutellum transverse, finely punctured, clothed with short, fine, recumbent pubescence. Elytra nearly four times as long as broad, coarsely punctured basally, more finely and sparsely apically; pubescence sparse, white, subrecumbent; apices rounded externally, unispinose. Legs slender; femora sparsely clothed with white, recumbent pubescence; tibiae carinate. Body beneath closely punctured, sparsely clothed with subrecumbent, white pubescence. Length 20–21 mm.; breadth 4–4.5 mm.

Holotype male (No. 4005, C. A. S. Ent.) and allotype female (No. 4006, C. A. S. Ent.), from Huachuca Mts., Arizona (collection of Dr. E. C. Van Dyke).

A. arizonica is most closely allied to *A. levetti* Casey, with which it agrees in general size and form. It may be easily separated, however, by the unispinose elytral apices and absence of elytral costae.

Aneflomorpha fisheri Linsley, new species

(Pl. I, Fig. 7)

Rather stout, reddish brown, evenly, not densely, clothed with recumbent, white pubescence. Head coasrely, closely punctured; eyes large, convex, coarsely granulated; antennae slightly longer than the body (♂), shorter than the body (♀), segments three to six sparsely ciliate within, feebly carinate, segments three to five spinose at apex. Pronotum transverse, subcylindrical, coarsely punctured except for a smooth, median vitta, sparsely clothed with moderately long, recumbent pubescence. Scutellum transverse, broadly rounded behind, very densely clothed with fine, white, recumbent pile. Elytra three times as long as broad, one-half wider at base than pronotum, parallel-sided; punctation coarse basally, finer sparser apically; pubescence white, subrecumbent, not dense; apices emarginate, the outer angle dentiform, the inner angle spiniform. Legs slender; femora sparsely pubescent and punctured; tibiae feebly carinate. Body beneath shallowly, rugosely punctured; abdomen clothed with long, white, recumbent pubescence. Length 15–20 mm.; breadth 4–4.5 mm.

Holotype male (No. 4007, C. A. S. Ent.), from Glen Ranch, Alpine, Texas, O. C. Poling, collector, and allotype female (No. 4008, C. A. S. Ent.) taken along the Devil's River, near Del Rio, Texas, May 25, 1932, by the writer, and numerous paratypes from each of the above localities in the collection of the California Academy of Sciences and of the writer. An additional paratype from Alpine, Texas, is in the collection of the United States National Museum.

Aneflomorpha fisheri may be easily distinguished from all of the other known species in the genus by its short, robust form and obsolete antennal and tibial carinae. It is with considerable pleasure that this species is dedicated to Mr. W. S. Fisher as a slight tribute for the repeated assistance he has given to the writer.

Aneflomorpha californica Linsley, new species

Elongate, slender, brownish piceous, sparsely clothed with rather fine, recumbent pubescence. Head coarsely punctured, sparsely pubescent; eyes very convex, coarsely granulated; antennae slightly longer than the body (♂), segments three to five carinate, spinose at apex, segments three to seven sparsely ciliate within. Pronotum slightly transverse, sides feebly tuberculate at the middle; disk very coarsely punctured except for a median, polished vitta; pubescence sparse, white, recumbent. Scutellum finely punctured, moderately densely clothed with fine, white, recumbent pile. Elytra three and one-half times as long as broad, parallel-sided, less coarsely and densely punctured than pronotum; pubescence fine, sparse, subrecumbent; apices bispinose, the sutural spine longer. Legs slender; femora sparsely pubescent. Body beneath shallowly, not densely punctured; abdomen sparsely clothed with fine, moderately short, white, recumbent pubescence. Length 15 mm.; breadth 3.3 mm.

Holotype male (No. 4009, C. A. S. Ent.), captured on Ash Mountain, Sequoia National Park, California, May 14, 1934, by Dr. Donald DeLeon.

This species is related to *A. lineare* with which it agrees in the short antennal spines, but it may be separated from that species by its larger size, dark-brown color, the short, sparse pubescence of the abdomen, and the prominently bispinose elytral apices.

Genus **Anepsyra** Casey

Anepsyra Casey, 1912, Mem. Col., 3: 291.

This genus is related to *Psyrassa*, differing in the densely pubescent pronotum and elytra and feebly carinate antennae. It also approaches *Aneflomorpha* from which it may be distinguished by the long, flying hairs of the body, obsolete antennal carinae and the long spine of the third antennal segment.

Genotype: *Elaphidion tenui* LeConte.

Anepsyra aculeatum (LeConte)

This species belongs in *Anepsyra* rather than in *Aneflomorpha* where it was placed by Casey. It is related to *A. tenui* and *A. volitans* Lec. but differs from both of these in the shorter spine of the third antennal segment and bispinose elytral apices. My examples are from Austin, Texas.

Genus **Stenelaphus** Linsley, new genus

Elongate, subparallel, sparsely clothed with long, erect setae. Head flat between the antennal tubercles, coarsely punctured, clothed with scattered, short, suberect setae; antennae slender, one-third longer than the body (♂), segments three to five spinose at apex. Pronotum rounded at the sides, wider at base than at apex; disk coarsely punctured, with three polished, longitudinal vittae. Elytra subparallel, very sparsely punctured, the punctures coarser and closer near the base; apices rounded, unispinose. Legs slender, sparsely punctured, sparsely clothed with suberect setae. Prosternum coarsely, closely punctured; metasternum and abdomen shining, sparsely punctured.

Genotype: *Elaphidion alienum* Leconte. (Pl. I, Fig. 2.)

This genus is distinguished from *Anoplium* and *Elaphidion*, with which genera it has been previously associated, by the long, erect setae of the upper surface, the carinate tibiae, and the peculiar arrangement of the elytral punctation (found also in *Stenosphenus*). *Stenelaphus* is closely related to *Stenosphenus*, from which it may be separated by the coarsely facetted eyes and the shape and sculpturing of the pronotum.

Genus **Stenosphenus** Haldeman

Stenosphenus Haldeman, 1847, Trans. Am. Phil. Soc. (2) 10: 39.
Thomson, 1860, Class. Ceramb., p. 372.
Thomson, 1864, Syst. Ceramb., p. 433.
Lacordaire, 1869, Gen. Col., 9: 130.
LeConte, 1873, Smiths. Misc. Coll., 11: 316.
LeConte and Horn, 1883, Class. Col., p. 301.
Horn, 1885, Trans. Amer. Ent. Soc., 12: 177.
Leng, 1887, Ent. Amer., 2: 193.

Lacordaire rather widely separated *Stenosphenus* from the Sphaerionini because of the finely facetted eyes. However, in the genus *Ironeus*, which Bates placed in the Sphaerionini, one species has coarsely facetted eyes, one moderately facetted eyes, and one finely facetted eyes. If these species are truly congeneric, this character loses much of its significance. Craighead[7] has pointed out that the larva of *Stenelaphus alienus*

[7]Craighead, F. C., 1923, North American Cerambycid Larvae, p. 72.

(which was formerly placed in *Elaphidion* and which in the adult stage has coarsely facetted eyes) can scarcely be distinguished from the larvae of *Stenosphenus* in structure or in habits. Likewise, an examination of the wing venation reveals that it is of the Phoracanthine-Sphaerionine type, not of the Callidine-Clytine type, with which it has been associated. In view of these facts and since *Stenosphenus* exhibits all of the structural characters generally associated with the Sphaerionini, including carinate antennae, carinate tibiae, spinose antennal segments and spinose elytral apices, I propose to place it in this tribe near *Ironeus*.

Genotype: *Callidium notatum* Olivier.

Genus **Psyrassa** Pascoe

Psyrassa Pascoe, 1866, Ann. Mag. Nat. Hist. (3) 18: 481.
Lacordaire, 1869, Gen. Col., 8: 322.
Bates, 1880, Biol. Centr.-Amer. Col., 5: 28.
Schaeffer, 1904, Journ. N. Y. Ent. Soc., 12: 61.
Pseudibidion Casey, 1912, Mem. Col., 3: 291.

This genus is rather closely related to *Anepsyra*, but differs in the shining, sparsely punctured pronotum. Bates (l. c.) states that in *Psyrassa* "the spine of the third antennal joint is remarkably long and this seems to be a good character." In typical species this is true, but in an equal number of others the spine is much reduced. The genus is dominant in Mexico, with one species in eastern United States and three in southeastern Texas.

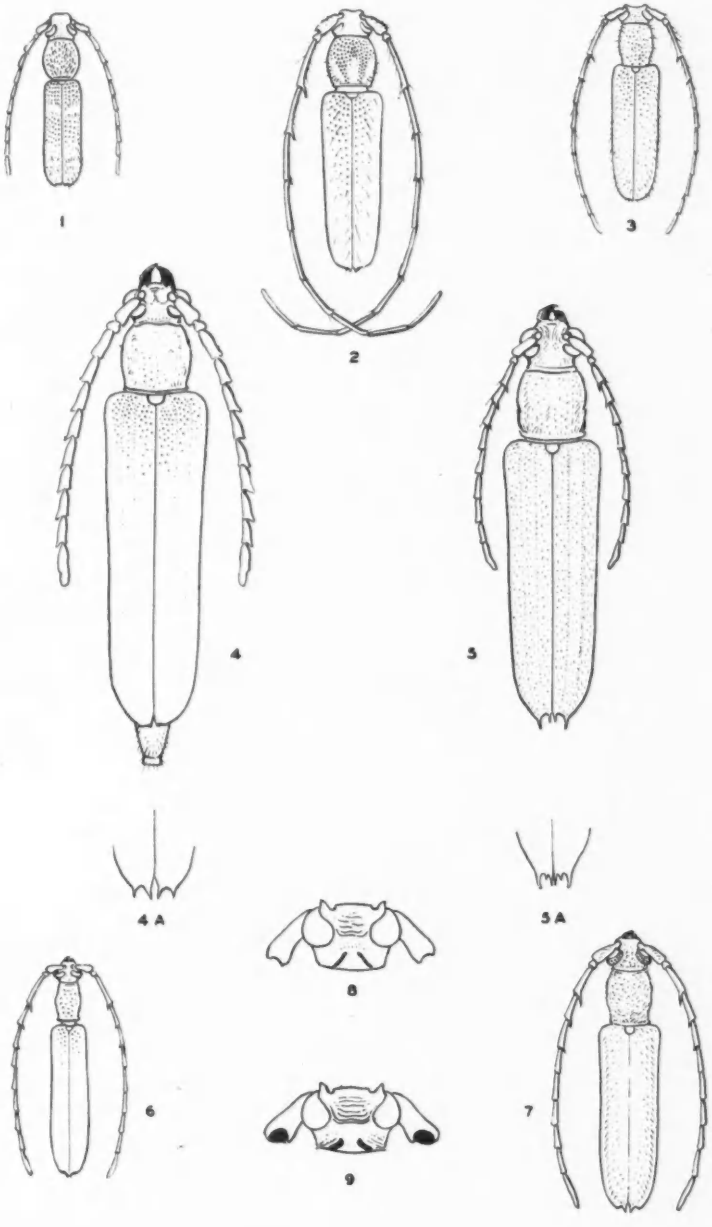
Genotype: *Psyrassa basicornis* Pascoe

Psyrassa unicolor Randall

This species is rather variable as regards the carinae of the antennae and tibiae. In some specimens the carinae are scarcely evident and in others present basally only. Likewise, the antennal spines may be long or short, sometimes scarcely evident.

EXPLANATION OF PLATE

Fig. 1. *Elaphidionopsis fasciatipennis* Linsley. (× 3.)
Fig. 2. *Stenelaphus alienum* LeConte. (× 3.)
Fig. 3. *Anopliomorpha rinconium* Casey. (× 3.)
Fig. 4. *Axestinus obscurus* LeConte, female. (× 2.)
Fig. 4a. Same, elytral species of male. (× 2.)
Fig. 5. *Aneflus sonoranus* Casey. (× 2.)
Fig. 5a. Same, showing variation in elytral apices. (× 2.)
Fig. 6. *Aneflomorpha elongata* Linsley. (× 2.)
Fig. 7. *Aneflomorpha fisheri* Linsley. (× 2.)
Fig. 8. *Aneflus rugicollis* Linsley, under side of head. (× 3.)
Fig. 9. *Aneflus basicornis* Linsley, under side of head. (× 3.)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THE LIFE CYCLE OF LABORATORY-BRED ANOPHELES ALBIMANUS WIEDEMANN

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The success of the Americans, under the leadership of Gorgas, in the fight against tropical diseases in Panama is now an old and well-known story. In the early construction days of the Panama Canal, the force of necessity directed the anti-mosquito campaigns against all of the Culicidae; there was no time to determine which were the important vectors of malaria, to study their habits, and to concentrate on them alone. Nevertheless, basic research was soon started; systematic studies were made by Jennings. Zetek, and Dyar; Darling (1910), in his infection experiments, found that *Anopheles albimanus* was the important malaria vector, while the Health Department of the Panama Canal began to accumulate a vast amount of data on the breeding habits of the Anophelines. The investigations on the mosquitoes have been maintained continuously by the Health Department; Dr. D. P. Curry has added to our knowledge of both the systematics and bionomics of the Isthmian Anophelines. Although we now know fairly well the breeding habits of the *Anopheles* larvae of Panama, a more thorough knowledge of the bionomics of the malaria vectors would be of aid in the solution of the malaria problem, and as a complete record of the life cycle of *Anopheles albimanus* bred in the laboratory might facilitate observations on its habits in nature, this report on the various stages in the life history of this mosquito is presented.

MATERIAL AND METHODS

The technique for breeding *A. albimanus* in the laboratory has been published in a separate paper (Rozeboom, 1936), but the essential points of the procedure would bear repetition.

The adults were kept in a screen cage 2 by 2 by 2 feet in size, and with a temperature of 80° to 86° F. and with a relative humidity of around 80 per cent. The temperature of the larval breeding water varied from 21° to 27° C., and that of the water containing the eggs and pupae from 27° to 30° C. The laboratory room temperature usually remained between 82° and 89° F., although occasionally it went down to 80° F., and at night, when the windows of the laboratory were closed, it rose at times above 89° F.

The eggs were removed from the breeding cage in the morning, and allowed to hatch in the laboratory. After a batch of eggs had hatched, the larvae were counted, and transferred to the breeding pans, which were kept out of doors. The breeding water consisted of well ripened alfalfa infusions, and the larvae were given fresh Fleischmann's yeast daily. Pupae were removed from the basins at least once a day, placed in cups of fresh tap water, and taken into the laboratory. Lantern globes were fitted above the cups, and after emergence, the adults were transferred to the breeding cage.

THE LIFE CYCLE

The Egg Stage.

Development of Ovaries and Oviposition.—Information concerning the egg-laying capacity of individual females, as well as evidence as to the period of time necessary for ovarian development, were obtained by the following experiment, which for convenience will be designated as *Experiment 1*. Ten engorged females and fifteen males, which had emerged about 12 hours previously, were placed inside a breeding cage similar to the one in which the stock colony is maintained. The mosquitoes were fed sugar-water and fruit, and the females were offered human blood daily. On the eighth day seven females were still alive; they were imprisoned singly in lantern globes, and each globe was placed above a cup of water. These globes were kept inside of the breeding cage, in order to keep the mosquitoes in an environment with a temperature of 80° to 86° F., and a relative humidity of around 80 per cent. Pads of cellucotton moistened with sugar-water were placed on the bobbinet tops of the globes, and each female was given an opportunity to suck human blood every day. A record was kept of the blood meals, the days when oviposition occurred, the number of eggs in each batch, and the number of larvae that hatched from the eggs. The females were dissected at the time of their death and the ovaries examined under a microscope.

Six of the seven mosquitoes deposited from two to six batches of eggs. Two oviposited for the first time during the night of the 9th day, three more during the night of the 10th day, and one during the night of the 12th day. Subsequent batches of eggs were usually deposited in intervals of two or three days, but occasionally a mosquito would wait a longer time between batches; one female laid her second batch eight days after the first. When the laboratory colonies were started, the first females to oviposit did so sooner than those in Experiment 1. Two separate laboratory colonies were established; the first eggs appeared after a period of seven days in one case, and after nine days in the other. It would seem, therefore, that a week, and usually a little more, is necessary for the maturation of the first eggs. It seems probable that the more unfavorable conditions accompanying imprisonment in a small container over a cup of water were the reasons why the females of Experiment 1 waited longer before ovipositing than did those in the laboratory colonies. This is shown most strikingly in the case of the female that refused to lay eggs. This insect lived for 24 days, and although her abdomen was distended with mature eggs, she refused to deposit them. She was also very reluctant to feed.

The smallest number of eggs in a single batch was 29; the largest number was 262. A total of 2,610 eggs were obtained in 20 separate batches, an average of 130 eggs per batch. The smallest number of eggs from any one female was 184, while the largest number was 788. As the 2,610 eggs were deposited by six insects, an average of 435 eggs were obtained per female. However, dissections showed that the only mosquito that appeared to have deposited all of the eggs she was capable of developing was the female that laid 788 eggs. At the time of her death her ovaries were entirely depleted. All of the remaining mosquitoes were found to have ovaries filled with eggs in various stages of development at the time they died. Although the number of insects used in this experiment was small, the results show that the egg-laying capacity of *A. albimanus* is similar to that of *A. tarsimaculatus* and *argyritarsis*. Moore (1929) demonstrated that females of both of these species can lay approximately 1,000 eggs apiece. Earle (1932) found that *A. albinamus* females averaged 160 eggs each, but this number would appear to be too small.

Of the 2,610 eggs, only 1,188, or 45.5 percent, hatched. This low percentage of fertility was probably due to the fact that after the females had been imprisoned in the lantern globes, they no longer had access to males; copulation was possible only during the period before the first eggs had matured. Thus the mosquito (#4) that deposited 788 eggs, did so in six batches; only 290 of these eggs were fertile, none of the eggs belonging to the last two batches, and only 11 of the fourth batch, being viable. On the other hand, two mosquitoes deposited nothing but non-viable eggs at first, while their second batches were fertile.

Immediately after laying eggs, these females were ravenous. Not a single mosquito in Experiment 1 failed to feed readily after oviposition. One blood meal was sufficient for the development of the second and subsequent batches, but occasionally two or three meals were taken between layings.

Oviposition was actually observed only once. One morning a gravid female belonging to the stock colony was found stranded in the egg trap. At 8:45 A. M. it was noted that this female was depositing eggs, and the process was watched under a lens. The eggs followed one another in intervals of 10 to 15 seconds. The first part of an egg would come out slowly; then, when almost half of the egg was protruding, there would be a sudden abdominal contraction, causing the egg to shoot out rapidly. Immediately after an egg was expelled, the tip of the next could be seen between the cerci. The female finished ovipositing at 8:55 A. M., having deposited a total of 129 eggs. These freshly-laid eggs were almost pure white in color; the exochorion and the floats were entirely colorless. The eggs were too small to fill in the space between the floats; later they swelled until the floats fitted snugly. By 10:30 A. M. the eggs had turned almost completely black, and at 10:50 A. M. were entirely so.

Observations made in the evening showed that oviposition first began around 6:30 P. M., at which time the egg trap never contained more than just a few light-colored eggs. At times the females did not begin to deposit their eggs until after 9:00 P. M. By 8:00 A. M.

oviposition had ceased. This was the earliest observation made in the morning, and it is quite certain that the females had stopped laying an hour or two before this. The stranded female that began to oviposit at 8:45 A. M. was the only mosquito, during several months of observation, that was ever seen to deposit eggs during the day.

Hatching.—Table I records the numbers of larvae that hatched from 48 batches of eggs. Collections of the newly-hatched larvae were made at 8:00 A. M., 11:00 A. M., 2:00 P. M., 5:00 P. M., and 7:00 P. M. The eggs usually began to hatch a little before 11:00 A. M. on the second day after the *beginning* of oviposition, about 40 hours after the first eggs had been found in the trap. It is assumed that the earliest larvae to hatch out came from the first eggs deposited. An examination of Table I

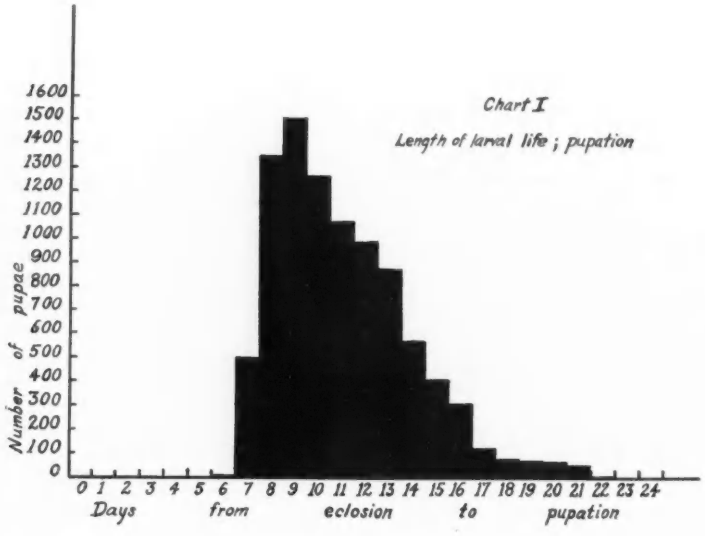
TABLE I

PERIOD OF TIME NECESSARY FOR HATCHING

OVIPOSITION		Days Following Oviposition	HATCHING				
			TIME OF COLLECTION Hours Following Oviposition; numbers of Larvae				
Started	Completed		8:00 A. M.	11:00 A. M.	2:00 P. M.	5:00 P. M.	7:00 P. M.
6:30 P. M.	8:00 A. M.	1st day	0–13½ hrs.				
		2nd day	24–37½ hrs.	27–40½ hrs. 312	30–43½ hrs. 5047	33–46½ hrs. 5907	35–48½ hrs. 6049
		3rd day	48–61½ hrs. 11,307	51–64½ hrs. 545	54–67½ hrs. 230	57–70½ hrs. 249	59–72½ hrs. 118
		4th day	72–85½ hrs. 68				

will show that the majority of the larvae were collected on the second day, at 2:00 P. M., 5:00 P. M., and 7:00 P. M., 30 to 35 hours after the eggs had been removed from the cage, or 43½ to 48½ hours after the beginning of oviposition. There is no reason to believe that the eggs hatching before the 2:00 P. M. collection had been deposited shortly before 8:00 A. M., and so these eggs were more than 30 hours old when they hatched. The larvae collected at 7:00 P. M. certainly did not come from eggs that had been deposited at 6:30 P. M., as only a few eggs were seen in the trap at that time; these ova, therefore, were less than 48½ hours old when they hatched. The majority of the larvae having been collected before or at 7:00 P. M. on the second day, the egg stage generally lasted less than 48 hours. On the other hand, some of the larvae collected at 8:00 A. M. on the third day, and all of those of the 11:00 A. M. collection, hatched from eggs that were more than 48 hours old, and the

few eggs hatching after the 7:00 P. M. collection on the third day were more than 59 hours old. The most accurate observation on the length of time necessary for hatching was that made on the eggs from the stranded female mentioned above, which were kept in a separate container and watched closely. This mosquito had deposited all of her ova within a few minutes, finishing at 8:55 A. M. Two days later, at 8:00 A. M., 27 larvae had already hatched out. At 8:30 A. M. 17 more were found, at 9:00 A. M. 11, and at 11:00 A. M. 8; two more appeared after 11:00 A. M. Thus the eggs of this batch did not all hatch at the same time. The first larvae to break out of the shell did so after a little less than 48 hours of development; the last came out after remaining in the egg for more than 50 hours.



It can be concluded, therefore, that a period of from 40 to 48 hours is generally necessary for hatching, although some stragglers need more time. Hatching can be delayed by certain external factors; it can be held up for a day by desiccation. When stranded on moist filter paper and placed in the ice-box, eggs will remain dormant for over a week.

Hatching was watched several times under a microscope. In each case the cap was suddenly pushed open, the head of the larva emerged on the ventral side and hung downwards in the water; the larva worked its way out of the opening and in a few seconds kicked itself free.

The Larval Stage.—Larval development was observed in nine basins during a period of two months. A total of 18,935 newly-hatched larvae were placed in the breeding pans, and of this number only 9,327, or 49.3 percent, reached the pupal stage. These observations were made

during the elaboration of a technique for the laboratory rearing of *A. albimanus*, and the high mortality was due to improper care of the larvae.

Chart I illustrates the duration of larval life in the infusion water. Those larvae that developed the most rapidly molted to the second stage on the 1st or 2nd day after eclosion, to the third stage on the 3rd or 4th day, and to the fourth stage on the 5th or 6th day. The first larvae to pupate did so during the 6th day. Most of the larvae pupated from the 8th to the 13th day, and more pupation occurred on the 9th day than on any other day. Following this peak, the chart shows a steady decline, and a few stragglers reached the pupal stage as late as the 22nd day. Thus the minimum larval life was 6 days, and the maximum 22, while the usual length of time spent in the larval stage varied from 8 to 13 days.

TABLE II

COLLECTION OF PUPAE; EMERGENCE OF ADULTS

COLLECTION OF PUPAE		EMERGENCE—DAYS FOLLOWING COLLECTION OF PUPAE					TOTAL NUMBER OF ADULTS
		1st Day Observation st				2nd Day Observation at 8:00 A. M.	
Time of Collection	Number Collected	8:00 A. M.	3:30–5:00 P. M.	6:00–7:00 P. M.	9:00–10:00 P. M.		
10:00 A. M.	3,097	585	335	1,246	65	6	2,237
1:00 P. M.	5,165	38	6	2,730	1,734	21	4,529
4:00 P. M.	3,938	.....	.....	398	2,365	474	3,237

The Pupal Stage.—The time of pupation and the duration of the pupal stage were determined as follows:

For two months the pupae were collected three times a day: at 10:00 A. M., 1:00 P. M., and at 4:00 P. M. These pupae were transferred to cups of fresh tap water, above which lantern globes were placed, and a record was kept of the number of adults that emerged at 8:00 A. M., 3:30 to 5:00 P. M., 6:00 to 7:00 P. M., and at 9:00 to 10:00 P. M. The results are summarized in Table II.

Sen (1935) states that in the case of certain Indian Anophelines, pupation occurs more often in the day than at night. This also took place in the laboratory colony of *A. albimanus*. Table II shows that of a total of 12,200 pupae, 3,097 were collected at 10:00 A. M. In other words, only a fourth of the mosquitoes pupated between the hours of 4:00 P. M. and 10:00 A. M., and of this number, no doubt a great many changed to the pupal stage shortly after 4:00 P. M. and a little before 10:00 A. M. Pupation always occurred most actively around noon.

The figures in Table II referring to the adults that emerged deal only with those mosquitoes that survived the process of emergence. The 585 and 38 adults in the 8:00 A. M. column of the first day do not

mean that these mosquitoes spent only about 24 hours as pupae; they emerged from the pupae that had been overlooked in previous collections.

Emergence usually commenced between the hours of 3:30 and 5:00 P. M., and, except for 6 individuals, always from pupae that had been collected at 10:00 A. M. on the previous day. It is not possible to determine the length of time spent in the pupal stage from the pupae collected in the morning, as pupation could take place throughout the night. A more accurate estimate can be made from the pupae collected at 1:00 P. M. and 4:00 P. M., as these pupae were not more than three hours old at the time they were taken out of the breeding pans. Table II shows that adults began to emerge from the 1:00 P. M. pupae shortly before 6:00 or 7:00 P. M. on the following day; the majority had already come out by 7:00 P. M., and with few exceptions, the remainder had emerged by 10:00 P. M. This gives a pupal stage lasting a minimum of about 30 hours, while the maximum could not be over 36 hours.

TABLE III

VIABILITY AND MORTALITY OF PUPAE AND ADULTS

	Pupae			Adults		
	Collected	Lived	Died	Emerged	Lived	Died
Number	39,782	33,623	6,159	33,623	30,024	3,599
Percentage	100.0	84.5	15.5	100.0	89.3	10.7

The mosquitoes pupating between 1:00 P. M. and 4:00 P. M. began to transform to he adult stage at about 6:00 to 7:00 P. M. on the following day, and had mostly completed their emergence by 10:00 P. M., giving a minimum pupal period of less than 30 hours, and, since 474 individuals emerged after the 9:00–10:00 P. M. observation, a maximum of over 33 hours. Assuming that the mosquitoes emerging first had been the first to pupate, the estimate of the maximum pupal period is too high. No doubt the majority of the mosquitoes remained in the pupal stage from 30 to 33 hours.

It has been a matter of routine, in following the progress of the laboratory colony, to record the number of pupae collected daily, and the number of dead and living adults. The number of mosquitoes that emerged was determined by counting the pupal skins, and the number that survived emergence was determined by subtracting the dead adults from the pupal skins. The pupal mortality was determined by subtracting the number of pupal skins from the number of pupae collected. Table III summarizes the viability and mortality of the pupae and adults over a six-month period. During this time, a total of 39,782 pupae were collected, of which 6,159, or 15.5 percent, died, while 33,623 lived; that is to say, 84.5 percent of the pupae produced adults.

The Adult Stage.—As has been stated above, emergence began between 3:30 and 5:00 P. M., and was usually completed by 10:00 P. M. This also conforms with the results of Sen (1935); he found that Indian Anophelines emerged between the hours of six to ten in the evening. Earle (1932) also observed that the most favorable time for emergence was just after sunset, although he says that his *albimanus* did not emerge during the day.

Table III shows that during the six-month period, 33,623 adults emerged, and that 3,599 of them, or 10.7 percent, died during or shortly after emergence.

In Table II, a total of 10,003 adults emerged and lived. Of this number, 4,268, or 42.7 percent, were males, and 5,735, or 57.3 percent, were females. Sen (1935) also counted more females than males among his mosquitoes; his results showed two males to three females.

Females were ready to suck blood the morning after emergence. As has been said before, a number of blood meals are taken during the insects' adult life.

Adults were active during the short twilight, and copulation took place at this time, from about 6:30 to 7:00 P. M., and also around 6:30 A. M. It was never observed during the day or night. Pairing occurred during flight, and many couples would strike the paper-covered floor of the breeding cage, where they would hesitate for a second or two before separating and flying away. During this interval it was noted that the position of the mating pairs was a ventral-ventral one, similar to that pictured by Boyd, Cain, and Mulrennan (1935). Referring again to Experiment 1, the increasing percentage of non-viable eggs in the later batches from mosquito #4 indicates that copulation, when possible, will take place more than once. That females will mate before having taken blood was shown by placing a number of unfed males and females in a breeding cage, removing the males on the second day; then giving the females blood. A number of eggs deposited by these mosquitoes were fertile.

The longest life observed in the adult stage was that of one of the females in Experiment 1, which endured 31 days. The longest male adult life observed inside a breeding cage was 24 days.

DISCUSSION

At the temperatures and humidity given under *Material and Methods*, the complete life cycle of the laboratory-bred *A. albimanus* was as follows: The maturation of the ova within the female mosquito required a week or more; the incubation period of the eggs lasted from 40 to 48 hours; from 6 to 22 days, but usually 8 to 13 days, were spent in the larval stage; adults emerged in late afternoon and early night after a pupal period of about 30 to 33 hours. The shortest length of time from egg to egg, therefore, could be 16 days, but usually 18 to 24 days were necessary for one generation, an average of three weeks.

The first question that comes to one's mind in a laboratory study of a dangerous mosquito is, to what extent can the results be applied to the insect in its natural environment? This can be answered only by detailed observations in the field. The many years of study on the Isthmian Anophelines has brought out that *A. albimanus* is highly

anthropophagous, that it is active after sundown and enters houses to feed on man; its breeding places are also well known. Nevertheless, there still are many gaps in our knowledge of the life history, particularly as regards the adults, and it is hoped that the results on the life cycle in the laboratory will point out methods for field investigations that will ultimately disclose all of this mosquito's habits and their relation to malaria transmission.

The natives of the Chagres River villages have assured the writer that they are painfully aware of the fact that mosquitoes become active at sundown, and there is no doubt that a large percentage of these pests are *albimanus*. The crepuscular activity of the writer's colony indicates that laboratory conditions have not changed this habit. The author has spent a great deal of time in collecting larvae and pupae of Isthmian mosquitoes, and on those occasions when he has collected continuously through the morning and into the afternoon, it was invariably noted that around noon and during the afternoon many more pupae were found than during the morning hours. It seems, therefore, that in nature also the majority of the mosquitoes pupate during noon and afternoon. This was true of *A. albitarsis* and *bachmanni* as well. If crepuscular activity and the time of pupation of "wild" and the laboratory mosquitoes are similar, it is not improbable that there is a close correlation between the remaining steps in the life cycle of the insects raised in the laboratory and those in nature, allowing, of course, for variations due to differences of temperature and humidity.

The voraciousness of females that have just completed oviposition has a direct bearing on the ability of *A. albimanus* to transmit malaria, as an infected mosquito, were she to deposit several batches of eggs, in her flights between breeding waters and source of blood meals, might have opportunities to inoculate sporozoites into several persons.

SUMMARY

A period of seven days, or a little more, was necessary for the development of the ovaries of *A. albimanus*, in a breeding cage with a temperature of 80° to 86° F. and a relative humidity of around 80 percent. In an experiment to determine the egg-laying capacity of the females, an average of 435 eggs were obtained from six mosquitoes, but only one of these insects appeared to have deposited all of the eggs she was capable of developing, judging from the depleted condition of her ovaries as compared with the many partially developed ova in the remaining five mosquitoes at the time of death. This female deposited 788 eggs. Each female oviposited from two to six times, and blood meals were always taken between layings. The smallest number of eggs in a batch was 29, the largest number was 262; in 20 batches there was an average of 130 eggs per batch. Oviposition took place during the night.

The eggs usually hatched after an incubation period of 40 to 48 hours, in water with a temperature of 27° to 30° C., although some needed a longer time. Hatching began at about 11:00 A. M. on the second day after oviposition, and occurred throughout the remainder of the day and night, during the third day, and some hatched as late as the night of the third day.

From 6 to 22 days, and usually 8 to 13 days, were spent in the larval stage, in hay infusion water in which the temperature varied from 21° to 27° C.

The majority of the larvae pupated during the day; pupation was most active around noon. In water with a temperature of 27° to 30° C., the mosquitoes usually remained in the pupal stage for 30 to 33 hours. Of 39,782 pupae, 15.5 percent died, and 84.5 percent produced adults.

With a few exceptions, emergence took place from 3:30 to 10:00 P. M., and 10.7 percent of 33,623 adults died during or shortly after emergence. Of 10,003 adults that survived emergence, 42.7 percent were males and 57.3 percent were females. Females were ready to suck blood the morning following emergence. Adults were active during the short twilight, from about 6:30 to 7:00 P. M., and around 6:30 A. M.; copulation took place during this time. Pairing occurred during flight, and the mosquitoes assumed a ventral-ventral position. Females were willing to copulate before sucking blood, and in nature copulation probably takes place more than once. The longest observed adult life of a female in a breeding cage was 31 days, of a male, 27 days.

In general, 18 to 24 days were necessary for the development of one generation, an average of three weeks.

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TENTHREDO

Acta Entomologica

There has just come to hand, Tenthredo, Vol. I, No. 1, pp. 1–108, 7 pls., a new entomological journal from the University of Kyoto, Japan. The advertisement is not clear but apparently one volume of four numbers will cover two years, the numbers appearing in May and November. The articles in Number 1 are in English and German. The paper, type and general format are excellent.

The present issue is wholly taxonomic, with articles on the Cicadafauna of the Carolines by Teiso Esaki, the Japanese Cricotopus and Corynoneura species (Chironomidae) by Massaki Tokunaga and the Tenthredinoidea of Saghalien by Kichizo Takeuchi. It is edited by Kichizo Takeuchi and is published by the Takeuchi Entomological Laboratory, Shinomiya Yamashina, Kyoto, Japan. Price $5.00 per volume.

After seeing Japanese electric light bulbs in the "5 and 10" at ten cents each, and bicycles laid down in Europe at $3.00 to $5.00 each, the price appears high but perhaps Japanese articles of high quality cost as much as do such in western lands.

Because of the name of this excellent new journal and because of its origin we think of Doctor Hachiro Yuasa, American trained, who organized entomological research at Kyoto. He has recently been made President of Doshiska University in Kyoto. We wish to extend respectful congratulations on this journal to the entomologists of Kyoto.—C. H. K.

STUDIES IN THE AMERICAN ARADIDAE WITH DESCRIPTIONS OF NEW SPECIES

(Hemiptera)

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The present paper deals largely with the abundance of material gathered during recent years in the collections of the California Academy of Sciences and the author, from the comparatively little known regions of the Western and Southwestern United States and Central Mexico. Appreciation is expressed to Dr. H. M. Parshley and Prof. W. S. Blatchley for information and material supplied by them, to Mr. E. P. Van Duzee for valuable assistance in working up the material as well as for permission to study the collection in his charge, and to several western Coleopterists, Dr. E. C. Van Dyke, Mr. R. L. Furniss, and Mr. E. G. Linsley, through whose field work so many of these interesting bugs have been collected. Dr. L. Bonar has very kindly determined the fungi.

ARADINAE

It is the author's purpose, here, to summarize the work done in this group since Parshley's supplement (1929), to offer certain biological generalizations which have come to mind, to make known some apparently new species as well as undescribed forms of known species, and to give additional host and distributional data for several species which have hitherto been considered as very rare or restricted to one locality.

One of the main features of Parshley's Essay (1921) was the type of illustration used to make clear certain characters, e. g., antennal, pronotal, and genitalic, which are not easily described in words. This feature is continued with the new species herein described and also for all of the other species described since 1921 and not included in Parshley's supplement. It is felt that this will make for uniformity in treatment of the group and all of the species concerned are, fortunately, at hand. Illustrations have been made by the author with a camera lucida and are semi-diagramatic, particularly as regards the pronotal carinae. All drawings are made with the same magnification and are therefore comparable except in the following species: *coarctatus*, *vandykei*, and *taylori*, where a higher magnification was used. The numbering and grouping follows that of Parshley (1921).

REVIEW OF RECENT WORK

The genus *Aradus* was very thoroughly treated by Parshley (1921). An additional distributional note on *Aradus debilis* Uhl. new to New

York, appeared by the same author (1924) and was followed by a supplement to his Essay (1929). In summarizing the work of the years 1921–1929 Dr. Parshley overlooked Van Duzee's paper (1927) in which were described *Aradus vandykei* and *patibulus* and in which *taylori* Van D. was resurrected from the synonymy to which it had been relegated by Parshley (1921). Biological and ecological information added since 1921 include a biology of *A. quadrilineatus* Say by Barber (1923), a life history of *A. cinnamomeus* Panz., the numerous host plant and distributional notes by Blatchley (1926), anatomical and biological notes by Weber (1930), a morphological study of *A. angustellus* Blanchard by Porter (1930), and a morphological study (eggs, nymphal instars and general biological remarks) of *A. cinnamomeus* Panz., *crenatus* Say, and *depressus* F. in Europe by Jordon (1932).

BIOLOGY

Any general biological remarks on such a widespread group as this are doomed to failure from the start not only because of differences in conditions throughout its range but because any group of organisms refuses to be forced into a man-made plan. However, out of the numerous records of field experiences during the past quarter of a century certain general principles become evident. These are useful if only as a criterion upon which to base future observation, judging each case separately and using it as a corroboration or refutation of the original statement.

The well-known habit of *Aradus cinnamomeus* Panz. of dwelling beneath bark scales at the tips of branches of living coniferous trees has best been stated by Kiritshenko (1913) and is, in so far as is known, unique among this otherwise mycetophagous group.

The occurrence of *Aradus debilis* in and about the ball fungus, *Polyporus* (*Cryptoporus*) *volvatus*, was first recorded by H. G. Hubbard (1892). This habit may now be extended to include *A. depressus* Fabr. in Europe (Jordon 1932) as well as *A. medioximus*, *intermedius* n. sp. and *parvicornis* which, together with *debilis*, have been taken at widely separated localities in California by the author. The occurrence of these closely related species on the same fungus plants at localities three hundred miles apart and the fact that they are only found under these conditions suggests that here again we have a unique type of biology common to a group of species. The bugs apparently live under the bark scales at the surface, coming out to feed upon the smooth surface of the fruiting bodies. If a bug is flipped off it will often be seen to hang with the rostrum pointing upwards, suspended sometimes one centimeter below by its slender setae which are deeply embedded in the fungus.

Specimens of the group beginning with *funestus* and including *furnissi* n. sp. and all of the *lugubris* group of which we have any first hand information are commonly taken in flight and at light. This habit was best stated by Van Duzee (1894) and has been borne out by many collections made since that time. Apparently here we are dealing with another special habit not as yet fully understood but certainly well-established and characteristic of this group.

Members of the genus *Aradus* are, in general, gregarious insects, nymphs and adults occurring in small colonies where conditions best suit them. Development is apparently very slow as last-instar nymphs required over one month to make their last ecdysis. The presence of nymphs even among over-wintering colonies is further evidence of this, as they no doubt are caught in the midst of development by the cold of winter. Jordon (1932) concludes from his extensive observations "that *Aradus depressus* never produces two generations a year" and that "the complete development from egg to adult may amount to almost a full year."

A mating and dispersal flight occurs in the spring, at which time adults may be found on the wing, in sweeping, at lights and screens, etc. Egg laying follows, whereupon the slow development to maturity takes place during the summer months. At this time adults are rather scarce and scattered, while nymphs may be found searching out the smallest fungi in cracks of bark or tumbling about in and on ball fungi.

In some regions a further dispersal takes place in the fall of the year before the cold of winter drives them into seclusion.

TAXONOMY

4. **Aradus ampliatus** Uhler

(Plate I, Fig. 4b)

Male. Very similar to female. Rostrum shorter, reaching posterior margin of prosternum. Hemelytra reaching almost to a level of apical angles of sixth abdominal segment, corium to middle of fourth; broadest not at anterior margin of third abdominal segment as in female but much posterior to this, at middle of fourth. Abdominal margin deeply notched, almost crenate (entire in female). Fifth and sixth ventral segments sub-equal in length, posterior margin of sixth obtusely angulately emarginate. Genital segment strongly convex, lobes short. Length 8.87 mm. Width 4.35 mm.

Described from a specimen in the author's collection taken by F. H. Wymore near Snowline, Eldorado Co., Calif., IV–18–'32.

In addition to the first occurrence of the male, several additional localities are here added for this very striking large species:

Mt. St. Helena, Calif., II–24–'29, E. C. Van Dyke Coll.; Nevada Co., Calif., VI–8–'33, E. R. Leach; near Snowline, Eldorado Co., Calif., IV–18–'32, F. H. Wymore; Carrville, Trinity Co., Calif., 2,400 ft. V–25–'34, E. C. Van Dyke.

4A. **Aradus patibulus** Van Duzee

(Plate I, Fig. 4A)

Van Duzee. 1927. Pan-Pac. Ent., 3: 140–141.

A very large and striking species which runs to *uniformis* in Parshley's key but is much larger, the rostrum slightly shorter, lateral mar-

gins of the pronotum coarsely, unevenly granulate, and antennae and genitalia very different (Figs. 4Aa and 4Ac).

The type is from Martin's Springs, Lassen Co., Calif., and additional specimens are now at hand from the following widely-scattered localities, ranging from Modoc County on the North to Sequoia National Park on the South: two specimens, Crescent Meadows, Sequoia National Park, Calif., 7,000–9,000 ft., VI–19–'29, E. C. Van Dyke; one at Potwisha, Sequoia National Park, 2,000–5,000 ft., VI–14–'29, E. C. Van Dyke; one, Yosemite Valley, Calif., VII–8–'21, E. C. Van Dyke; and one at Hacamore, Modoc Co., Calif., IV–15–'34, K. A. Salman, all females.

4B. **Aradus linsleyi** Usinger, n. sp.
(Plate I, Fig. 4B)

Nearest to *patibulus* Van D. but slightly larger, much lighter, second antennal segment thickest at base, and scutellum differently shaped.

Female. Head a little longer than broad (18: :16); tylus longer than in *patibulus*, narrower than in *ampliatus* Uhl. and with sides more nearly parallel than in either of these; impressions of vertex black, clearly defined, twice as long as broad, surrounded by rows of coarse, light granules; pre-ocular and post-ocular tubercles very small, inconspicuous among the very large granules; antenniferous spines only very slightly divergent, longer and sharper than in *patibulus* but shorter, not so sharp, and much less divergent than in *ampliatus* with lateral teeth less conspicuous than in either of these. Antennae very similar to *patibulus*, second segment slightly more slender apically to apical one-fifth where it is again enlarged to almost the thickness of base, third segment cylindrical, slightly more than one-half length of second, fourth slightly less than one-half second; proportion of segments 1 to 4, 4 : 13 : 7 : 6. Rostrum reaching almost to posterior margin of front coxae (attaining middle of front coxae in *patibulus* and anterior forth of mesosternum in *ampliatus*). Pronotum as long as width of head, widest at middle; transverse depression rather deep; lateral margins unevenly, finely denticulate, broadly expanded and reflexed as in *ampliatus* but with the lateral angles more rounded as in *patibulus* and the carinae less distinct; posterior margin more deeply emarginate as in the two species mentioned above. Scutellum longer than pronotum (23::16), triangular as in *ampliatus* but with the apex more acute, sides nearly rectilinear, slightly more converging from apical fifth to apex (concavely sinuate at middle in *patibulus* and then sub-parallel to broadly-rounded apex); disk only slightly elevated basically (distinctly elevated on basal one-half in *patibulus* with another "T"-shaped elevation surmounted on this, the median carina extending posteriorly for a distance equal to width at base between elevated sides); sides distinctly elevated but less so than in *ampliatus*. Hemelytra narrowed, exposing a considerable portion of disk of abdomen at sides; extending onto base of genital segment; corium to base of fourth segment; exocorium broadly and evenly expanded at base (more so than in *patibulus*), moderately reflexed (less than in *ampliatus* but more than in

patibulus); veins of corium only slightly elevated, a single light cross vein in mesocorium and a small longitudinal cell at base limited by a row of coarse granules; membrane with distinct but very confused branching and anastomosing veins. Abdomen broadly ovate, at widest point a little less than twice width of pronotum. Female genitalia much as in *patibulus*, posterior margin of dorsal genital segment distinctly sinuate, genital lobes rather evenly rounded.

Color light brown to testaceous, second antennal segment, except at base, third and fourth segments, eyes, impressions of vertex, anterior lobes and carinae of pronotum, scutellum, except for apex of disk, granules at margin of connexivum broadly at base and apex of each segment, round group of granules at outer basal angle of segments of disk of abdomen, basal and apical angles of dorsal genital segment and genital lobes, apex of corium, legs except for sub-apical testaceous ring on femora, basal and sub-apical testaceous rings on tibiae, and tarsi except extreme tips, underside of body generally except for expanded lateral regions dark brown to black. Membrane with scattered fuscous spots. Two rounded disks on margin of abdominal disk light testaceous, otherwise, except for dark areas, tinged with reddish as are connexivum and venter.

Length 10.2 mm., width 5.2 mm.

Holotype, female, No. 3956, Calif. Acad. Sciences, Yosemite National Park, Calif., VI–6–'31, 4,000 ft., E. G. Linsley. It is with a great deal of pleasure that I dedicate this handsome species to Mr. E. G. Linsley whose association has proved a constant source of inspiration over a period of years.

Linsleyi, together with *patibulus* Van D., may best form a new group which shows relationships to Parshley's "Ampliatus" group, where it has been placed in this work, and to the same author's "Compressus" group in its relationship to *uniformis*.

7. **Aradus coarctatus** Heidemann

(Plate I, Fig. 7a)

This distinctive little species has been turning up in increasing numbers from the southern part of California. The female differs from the male in size and shape, the rostrum extends over anterior fourth of mesosternum, the hemelytra attain middle of dorsal genital segment, the posterior margin of which is only faintly emarginate at middle. Genital lobes short and rounded. Ventral genital characters as in Figure 7a.

Length 5.5 mm., width (connexivum) 2.8 mm.

Described from a female in the collection of the California Academy of Sciences, Colton, Calif., I–13–'10, G. R. Pilate.

12. **Aradus intectus** Parshley

An additional specimen of this species has turned up, this time from Selkirk, Y. T., Can., VI–9–'28, R. E. Barrett. It

was formerly known only from Wyoming, Colorado and Manitoba.

15. **Aradus apicalis** Van Duzee

Numerous specimens from many localities indicate that this species should no longer be considered as rare. It appears to be generally distributed throughout the Sierras. It was taken in a rotten stump of *Pinus jeffreyi* at Fallen Leaf Lake, El Dorado Co., Calif., VII–21–'29, by the author.

15A. **Aradus vandykei** Van Duzee
(Plate I, Fig. 15A)

Van Duzee. 1927. Pan-Pac. Ent., 3: 139–140.

Overlooked by Parshley (1929). The figure is from the type.

18. **Aradus concinnus** Bergroth, 1892
(=**Aradus depictus** Van Duzee, 1917)

Aradus depictus was not originally compared with *concinnus* and was only associated with that species later by Parshley who distinguished it by antennal coloration. This coloration intergrades imperceptibly from one extreme, *depictus*, to the other, *concinnus*, in the long series at hand. The other distinguishing character given is the "shape of the scutellum." However, it is not stated what this scutellar difference is and it appears very much as if these words were simply quoted from Bergroth (1892). Bergroth said that his *concinnus* was "readily distinguished by the shape of the scutellum" but he did not know *depictus* at that time.

Parshley states that individual variation is exceedingly great in *depictus* and in the long series of both forms at hand the shape of the scutellum is slightly variable, as is the color of the disk, but there appear to be no significant constant differences.

The localities intergrade as the allotype of *depictus* was from Claremont (So. Calif.) and *concinnus* is at hand from Sequoia National Park and the Oakland Hills. Bergroth described *concinnus* from a single male from Southern California without definite locality. He later described the female from a series of both sexes received by him from Mr. Heidemann collected at Palm Springs, Calif. Specimens in the E. P. Van Duzee collection from this same Palm Springs series have been examined while studying the synonymy of this group.

19. **Aradus proboscideus** Walker

Numerous host records for this widespread species may be added as follows: Nymphs and adults from a single fruiting body of a fungus on *Abies magnifica* on the north slope of Mt. Shasta, Calif., VI–17–'34, R. L. Furniss; *Abies concolor*, Echo

Lake, Calif., R. L. Usinger, and Klamath Falls, Ore., R. L. Furniss; *Pinus ponderosa*, Yosemite National Park, Calif., E. O. Essig.

19A. **Aradus taylori** Van Duzee
(Plate I, Fig. 19A)

Resurrected from synonymy by Van Duzee (1927). This species may be readily separated from the above by the shorter rostrum which reaches only to posterior margin of prosternum. Genitalic characters are shown in figure and were drawn from the types. The range is extended to California and Utah by the following examples in the collection of the California Academy of Sciences: three males, Yorkville, Mendocino Co., Calif., IV–24–'28, E. P. Van Duzee; and one male, Provo Canyon, Wasatch Mts., Utah, VI–11–'30, E. C. Van Dyke.

21A. **Aradus serratus** Usinger, n. sp.
(Plate I, Fig. 21A)

Runs to *consors* Parshl. in Parshley's key but with pronotum widest behind middle and abdominal margin almost entire.

Female. Head longer than broad (30 :: 24), much longer than pronotum (30 :: 23); tylus very little enlarged, its sides parallel; impressions of vertex deep, oblique, ill-defined; pre-ocular and post-ocular tubercles distinct, sub-acute; antenniferous spines long, slender, acute, lateral teeth inconspicuous. Antennae almost cylindrical, scarcely thicker apically, at widest point distinctly more slender than front femora ($3\frac{1}{2}$ :: $5\frac{1}{2}$), slightly longer than head and pronotum together; length of segments one to four in proportion of 5 : 29 : 12 : 11; second segment slightly enlarged at tip. Rostrum reaching anterior fourth of mesosternum. Pronotum much as in *consors;* carinae moderately elevated; median transverse depression rather shallow; anterolateral margins lightly reflexed, coarsely, rather regularly serrate; posterior margin before scutellum straight. Scutellum about as long as head, triangular; sides slightly arcuate; apex narrowly rounded. Hemelytra short, reaching only to base of sixth abdominal segment, corium to base of fourth; strongly narrowed, exposing a width of abdominal disk equal to one-half width of connexivum; exocorium strongly, evenly expanded at base and rather abruptly reflexed; corium with numerous, more or less distinct, transverse veins. Abdominal margin almost entire with only small notches at the sutures. Genitalia much as in *proboscideus* but with the dorsal genital segment more transverse, only a little more than half as long as broad, with the lobes less rounded than in that species or *consors*.

Color rather uniform light grayish brown. Basal dilations of exocorium, cross veins of corium, and posterolateral tips of connexival segments light testaceous. Apex of corium and membrane irregularly marked with black. A few spots on dorsal surface and entire ventral surface in great part reddish brown.

Length 9.38 mm., width 4.29 mm.

Holotype, female, No. 3957, California Academy of Sciences, Kanaskis, Alberta, Canada, V–12–'28, Owen Bryant. This species may be referred to Parshley's "Proboscideus" group, where it follows *consors* in the arrangement given.

23. **Aradus persimilis** Van Duzee

In a series of this species from various localities in the Western United States all females exhibit some degree of brachyptery. The tips of hemelytra scarcely surpass the fourth abdominal segment in three specimens and scarcely surpass the fifth in another whereas in still another they reach almost to genital segment. This should be added to our list of polymorphic species.

24. **Aradus medioximus** Parshley

(Plate I, Fig. 24)

Male. Very similar to female (compared with a paratype from Vancouver Island) but smaller with the abdomen differently shaped, narrowed anteriorly and very broad posteriorly; hemelytra longer, in one specimen reaching well beyond apices of sixth abdominal segment. Posterior margins of third and fourth ventral segments deeply emarginate, fifth roundly emarginate with a smaller, obtusely rounded emargination at middle, sixth deeply emarginate for reception of genital segment and with a very shallow emargination at middle. Genital segment convex, lobes evenly rounded and following rather well the curve of the abdomen.

Length 6.9 mm., width 2.6 mm.

In the very closely related *persimilis* the posterior margin of sixth ventral segment is quite deeply, roundly emarginate and the lobes are toothed near outer apical angle.

Described from a specimen in the author's collection, Ochoco National Forest, Oregon, II–28–'34, 3,500 ft., W. J. Buckhorn.

Parshley's holotype of this species is from "California," his paratypes from Vancouver Island, B. C. Numerous definite localities as well as several specific hosts may now be added as follows: Shasta Springs, Calif., VI–23–'20, C. L. Fox; Hackamore, Modoc Co., Calif., Pinus ponderosa, numerous dates from April to August, W. J. Buckhorn, J. W. Bongberg, R. L. Furniss, G. L. Smith, and R. L. Usinger, collectors; Ochoco National Forest, Ore., II–28–'34, 3,500 ft.; Klamath Falls, Ore., Abies concolor, R. L. Furniss; Carrville, Trinity Co., Calif., IV–7–'34, E. C. Van Dyke; Modoc National Forest, Calif., K. A. Salman; and Bass Lake, Fresno Co., Calif., 4,000 ft., VI–15–'32, R. L. Furniss.

27A. **Aradus intermedius** Usinger, n. sp.
(Plate II, Fig. 27A)

Near *parvicornis* Parshley, but with the antennae longer, subequal to length of head and pronotum together, rostrum longer, attaining anterior margin of mesosternum, male genital lobes shorter, following the curve of the abdomen.

Male. Head slightly longer than broad including eyes (19 : : 17), longer than pronotum on the median line (19 : : 15); tylus large, slightly bulbous; impressions of vertex rather deep and large, joining posteriorly; pre-ocular and post-ocular tubercles much as in *parvicornis*, distinct but not acute; antenniferous spines short, acute, with only small lateral teeth. Antennae relatively long and slender, sub-equal in length to head and pronotum together; proportion of segments one to four as 4 : 14 : 8 : 8, first segment not reaching to middle of tylus, second slightly longer than width of interocular space including one eye, almost cylindrical, very slightly enlarged at apex, third cylindrical, fourth subcylindrical, pyriform, much more slender than in *parvicornis*. Rostrum reaching to anterior margin of mesosternum (reaching not quite to base of prosternum in *parvicornis*). Pronotum with transverse depression rather deep; lateral margins sinuate, distinctly, irregularly serrate; posterior margin deeply emarginate, emargination lightly trisinuate as in *parvicornis*. Scutellum sub-equal in length to head and rather broad, converging apically and lightly angled at middle, only slightly elevated. Hemelytra with exocorium lightly expanded and membrane reaching almost to apex of genital lobes. Genital segment much as in *parvicornis* but with the lobes considerably shorter, their margins following well the curve of the abodmen.

Color variegated. Head fuscous, depressions of vertex black, tips of antenniferous spines, serrations of sides of pronotum, and granules on head white. Eyes rufo-piceous. Antennae dark fuscous, apical half of first segment and extreme tips of second and third lighter, fourth segment black. Rostrum ferrugineous, becoming darker toward apex of second and third segments. Pronotum with anterior lobe between the carinae black, basal lobe light testaceous, ferrugineous to testaceous on margin. Scutellum uniformly dark ferrugineous to fuscous on basal elevated half, white on apical half except for two sub-apical infuscations on the lateral elevations. Connexival segments variegated, each with a black basal and apical angle. Corium very dark, cells and a great many of the veins black, exocorium brown. Membrane dark with white veins. Legs fuscous to fusco-testaceous, the sternal plates surrounding coxae, trochanters, and spots on femora and tibiae lighter. Ventral surface largely black, under surface of head lighter; prosternum and pleura, narrow central portion of mesosternum, and metasternum yellow. Under side of exocorium posteriorly, margins of venter, and portions of sixth and genital segments yellow.

Length 5.6 mm., width (connexivum) 2.1 mm.

Female. Antennae slightly shorter than head and pronotum together, tylus more bulbous than in the male; scutellum slightly broader than in male; and hemelytra attaining basal fourth of dorsal genital segment.

Posterior margin of dorsal genital segment evenly, lightly rounded or with a slight emargination at middle. Genital lobes even shorter than in *parvicornis* (figure 24Aa). Sides of abdomen evenly rounded.

Length, 6.23 mm., width (at connexivum) 2.63 mm.

Holotype, male, No. 3958, Calif. Acad. Sciences, Tamarack Lake, El Dorado Co., Calif., 7,700 ft., VII–28–'34, R. L. Usinger, on a ball fungus *Polyporus volvatus* growing on *Abies concolor*. Allotype, female, No. 3959, Calif. Acad. Sciences and one male and three female paratypes, same data as type. Other paratypes, one male, Buck Creek, Modoc Co., Calif., VIII–'31, K. A. Salman; one male, Willow Ranch, Modoc Co., Calif., on *Pinus ponderosa;* nine specimens, Hackamore, Modoc Co., Calif., six of them, VIII–25–'34, two, VIII–4–'34, J. W. Bongberg, ex *P. ponderosa;* and one male reared from a nymph taken by the author on *Polyporus volvatus* growing on *P. ponderosa* at Hackamore, VII–3–'34.

It is interesting to note that the four species, *medioximus*, 24; *intermedius*, 27.A; *debilis*, 26; and *parvicornis*, 28, which are all in the same group and closely related, are all found together on the same balls of fungus in Modoc and El Dorado counties some four hundred miles apart.

28. **Aradus parvicornis** Parshley

(Plate II, Fig. 28)

Male. Similar to the female in every particular except for the typically modified abdomen, narrowed anteriorly; hemelytra extending well beyond level of apices of sixth abdominal segment; corium to base of fifth. Genital segment very large, lobes extending beyond apices of sixth abdominal segment by about half the length of abdominal segment, their apical margins entire.

Length 5 mm., width 1.9 mm.

Described from a specimen in the author's collection, Pacific Grove, Monterey Co., Calif., IX–5–'20, F. E. Blaisdell.

Additional distributional notes for this hitherto rare species follow: Pacific Grove, Monterey Co., Calif., IX–5–'20, F. E. Blaisdell; Fallen Leaf Lake, Eldorado Co., Calif., VI–14–'30, A. T. McClay; Chiquito, Fresno Co., Calif., VIII–25–'32, R. L. Furniss; Hackamore, Modoc Co., Calif., VI–4–'34, VIII–4–'34, VIII–25–'34, J. W. Bongberg and R. L. Usinger; and Buck Creek, Modoc Co., Calif., VIII–'31, K. A. Salman. New host records are *Pinus jeffreyi*, (Chiquito), R. L. Furniss, and *Pinus ponderosa* on *Polyporus volvatus* (Hackamore), J. W. Bongberg and R. L. Usinger.

34. **Aradus blaisdelli** Van Duzee

A series of one hundred last instar nymphs of this species was collected at Happy Camp, Modoc Co., Calif., VI–3–'34, by the author on a fallen trunk of *Pinus ponderosa*, where the bugs were feeding upon a fungus of the genus *Poria*.

The third antennal segment is white in nymphs of this species in contrast to the only slightly pale condition in adults. When picked up with forceps they ejected a fluid from the tip of the abdomen which extended for several inches. The bugs completed this last ecdysis and became adults on July 10, thus indicating a very slow development at least under laboratory conditions.

34. **Aradus compressus** Heidemann

This species appears to be rather common in our Western states. It has turned up in considerable numbers from numerous localities in Washington and Oregon and may now be recorded from California for the first time with the following widespread records: Sand Flat, Calif., 5,500 ft., VI–17–'30, E. O. Essig and E. G. Linsley; Pohono Trail, Yosemite, Calif., 7,000 ft., VI–17–'31, E. G. Linsley; Huntington Lake, Fresno Co., Calif., VII–17–'19, 7,000 ft., E. P. Van Duzee; Hackamore, Modoc Co., Calif., R. L. Furniss; Facht, Lassen Co., Calif., VI–11–'22, J. O. Martin. *Pinus contorta murryana* may be added as a new host (Huntington Lake, E. P. Van Duzee).

42. **Aradus parshleyi** Van Duzee

Heretofore known only by the unique type from Vernon, British Columbia, a single female example may now be recorded from Sequoia Nat'l. Park, Calif., 7,000–9,000 ft., VI–24–'29, E. G. Linsley.

43A. **Aradus furnissi** Usinger, n. sp.
(Plate II, Fig. 43A)

A moderate-sized rather variable species which is sexually dimorphic and not closely allied to any previously described form. Runs to couplet 40 in Parshley's key from whence the two sexes diverge. If the male, alone, is considered from this point on, it runs to *gracilicornis* but differs greatly from this species.

Male. Head longer than broad (18 : : 15) and much longer than pronotum (18 : : 11); tylus only slightly bulbous, its sides sub-parallel, converging apically; impressions of the vertex well-defined; pre-ocular and post-ocular tubercles distinct, obtuse; antenniferous spines short, acute, divergent, lateral teeth obsolescent. Antennae long and slender, two-thirds as thick as front femora and slightly longer than head and pronotum together; segments one to four in proportion of 4 : 14 : 6 : 6,

beset, in apical half, with very fine, sparse hairs often exceeding, in length, thickness of segments; first segment reaching slightly beyond middle of tylus, second subequal in length to width of head including eyes, gradually thickened from slender base to apex. Rostrum reaching front coxae. Pronotum widest well before middle, transverse impression distinct laterally, carinae little elevated, almost obsolete near anterior margin; lateral margins entire or lightly granulate, distinctly sinuate; posterior angles broadly rounded; posterior margin deeply, roundly emarginate. Scutellum as broad as length of pronotum and slightly longer than broad (13 : : 11), sub-triangular in outline with sides rounded to rather blunt apex; disk lightly elevated in middle. Hemelytra little dilated at base, strongly, roundly narrowed in apical half; margins of exocoria sub-parallel, only slightly wider than pronotum (25 : : 24); reaching to middle of dorsal genital segment and exposing a considerable portion of connexivum; corium reaching to posterior margin of fourth connexival segment, with but few, indistinct cross-veins; membrane hyaline. Genital segment moderately convex, apical lobes sub-truncate, slightly exceeding curve of abdomen.

Color reddish brown, becoming darker on third and fourth antennal segments, scutellum, clavus, apex of corium, and center of each connexival segment. Impressions of vertex, eyes, and anterior lobe of pronotum between carinae black. Margins of pronotum and posterior lobe in great part, transverse sub-basal vittae on endocorium and exocorium, cross-veins of corium and apex and elevated center of scutellum and connexival segments except for black central areas yellow. Legs testaceous to fusco-testaceous. Venter reddish brown. Rostrum darker and becoming still darker apically. Mesosternum and metasternum very dark brown.

Length 4.55 mm., width 1.55 mm.

Considerable variation is exhibited as regards length and thickness of antennae; shape of scutellum, which is often longer and sometimes appears distinctly pentagonal and usually has its sides elevated; and length of hemelytra, the membrane reaching tip of abdomen in some specimens.

Female. Very different from male as follows: tylus distinctly bulbous; pre-ocular tubercles and lateral teeth of antenniferous spines prominent, acute. Antennae much shorter than head and pronotum together (29 : : 36); antennal segments in the proportion of 4 : 12 : 6 : 7; second segment scarcely longer than interocular space. Antero-lateral margins of pronotum lightly but distinctly serrate, anterior tooth often quite prominent. Hemelytra short, reaching only to basal half of dorsal genital segment; rather strongly narrowed posteriorly exposing a portion of abdominal disk; exocorium strongly dilated, width of hemelytra at this point greater than width of pronotum (38 : : 34), cross-veins of corium numerous and distinctly elevated. Posterior margin of dorsal genital segment roundly emarginate, straight just at middle; genital lobes short, following well the curve of the abdomen. Ventral genital characters very distinctive, the pieces of first and second genital segments overlapping, (Fig. 43Aa) and appearing different from any other species known to the author.

Color much lighter than in male due to great expanse of yellow exposed on connexivum which is regularly patterned with yellow and black on each segment. Extreme tips of second and third antennal segments pale, fourth fusco-piceous, tylus reddish.

Length 6.1 mm., width (at connexivum) 2.5 mm.

Holotype, male, No. 3960, Calif. Acad. Sciences, Hackamore, Modoc Co., Calif., X–5–'34, ex *Pinus ponderosa*, J. W. Bongberg. Allotype, No. 3961, Calif. Acad. Sciences, same data as type. Paratypes, 16 specimens, same data as type; four specimens, same but VIII–25–'34; one female, VI–15–'34, J. W. Bongberg; and one male and one female, same locality as type, X–10–'32, R. L. Furniss. In addition one female, Yosemite Valley, 4,300 ft., II–26–'34, *Pseudotsuga taxifolia;* two males, Levining Canyon, Mono Co., Calif., IX–22–33, *Pinus jeffreyi;* and one male, Wawona, Mariposa Co., Calif., IX–29–'33, *Pinus lambertiana*, have been collected by Dr. D. DeLeon.

It is with considerable pleasure that I dedicate this species to Mr. Furniss, whose field work has done so much to add to our knowledge of these interesting insects. Mr. Bongberg states that this species was very abundant, flying about and resting on twigs and branches and also appearing in bark cages during the month of October.

In its flight habits it approaches the "*Lugubris*" group and should form a new group to be placed just before this in Parshley's arrangement.

51. **Aradus uniannulatus** Parshley

Formerly known only from the Eastern United States and Alberta. Two Western localities may now be added: Long's Peak Inn, Colo., 9,000 ft., VII–2–'24, E. C. Van Dyke, and Gold Lake, Sierra Co., Calif., VI–20–'34, L. S. Rose.

53A. **Aradus brunnicornis** Blatchley

(Plate II, Fig. 53A)

This species should have been associated with *falleni* Stål by Blatchley as the second antennal segment is not strongly narrowed in basal third as in *lugubris*. A female cotype kindly communicated by Prof. Blatchley differs from typical specimens of *falleni* only in its narrower abdomen. The third antennal segment is one-half the length of second, whereas it is two-thirds the length of second in *falleni*, but Parshley states that the proportion of the antennal segments is variable in *falleni*. If an examination of the male genital segment of *brunnicornis* shows the same peculiarly sinuate margins of genital cleft as in *falleni*, *brunnicornis* will fall very close, indeed, to that widespread and somewhat variable species.

54A. **Aradus mexicanus** Usinger, n. sp.
(Plate II, Fig. 54A)

Very near *snowi* Van D. and will run to that species in Parshley's key (1921) but larger, darker, antennae more slender and much less narrowed on basal third of second segment. Scutellum slightly broader with sides sub-parallel on basal fourth.

Male. Head as long as broad including eyes, longer than pronotum on median line (19 : : 16); tylus with sides sub-parallel or faintly enlarged toward apex; impressions of vertex very clearly defined, smaller than the eye, with their front margins a little anterior to front margin of eyes, not joining before or behind; pre-ocular and post-ocular tubercles inconspicuous, rounded; antenniferous spines of moderate size, dull, slightly divergent and without lateral teeth. Antennae more slender than front femora (2½ : : 3), distinctly thicker than front femora in *snowi* (3 : : 2½); shorter than head and pronotum together (31½ : : 36); first segment reaching a little beyond middle of tylus, second scarcely longer than interocular space; proportion of segments one to four 3½ : 13 : 8 : 7; second segment slightly narrowed in basal one-third, over half as thick at base as at apex (1½ : : 2½), (very strongly narrowed in basal third in *snowi*, only one-third as thick at base as at apex); fourth segment narrower and longer than in *snowi*. Rostrum extending over anterior fifth of mesosternum. Pronotum as in *snowi*, moderately convex, widest behind middle, moderately expanded posteriorly with lateral margins granulate; carinae moderately distinct; basal margin almost rectilinear, very little emarginate. Scutellum distinctly longer than pronotum (22 : : 16), its width at base equal to length of pronotum; sides sub-parallel in basal fourth, then almost straight to narrowly rounded apex, strongly elevated; disk fully elevated on basal half. Hemelytra attaining apex of abdomen, corium to middle of third segment. Connexivum exposed from middle of third segment. Endocorium and exocorium very slightly expanded, width across body at this point equal to width of pronotum behind; endocorium and clavus with numerous cross-veins which disappear in the middle of the cells. Fifth ventral segment shorter than sixth on median line. The latter deeply notched to receive genital segment. Base of notch emarginate, the margins, either side of middle, evenly arcuate. Genital segment convex.

Color dark brown to black, veins of corium, venter and legs lighter brown, cells of corium and membrane whitish hyaline. Dark brown at base and apex of clavus and round brown spots on the membrane half way between apex of endocorium and apex of mesocorium and at the inner apical angles of mesocorium as well as a few very light and indistinct spots toward the apex. Apical one-third of second antennal segment white (apical half white in *snowi*), third, extreme base excepted, white, fourth lightly infuscated, uniform soiled testaceous. Oblique pale lines at base of head very faint. Outer apical angles of connexival segments and narrow margins at apex of median cleft of genital segment white.

Length 4.5 mm., width 1.46 mm.

Holotype, male, deposited on loan, Calif. Acad. Sciences,

taken by Mr. H. E. Hinton and the author on a light sheet, Real de Arriba, Temascaltepec, Mexico, VI–4–'33.

The other species of this genus reported from Mexico are the widespread *falleni* Stål, C. H. T. Townsend, Yucatan (Bergroth, 1895), *lugubris* Fall., Lower Calif. and Mexico (Uhler, 1894), *crenatus* Say, Mexico (Bergroth, 1895), and *niger* Stål, Mexico, in Cornell Collection (Parshley, 1921).

54B. **Aradus fuscipennis** Usinger, n. sp.

(Plate II, Fig. 54B)

Runs to *gracilicornis* Stål and *abbas* Bergr. in Parshley's key. Antennae unicolorous as in *gracilicornis* but much thicker, recalling *funestus* Bergr. Hemelytra much as in *abbas* and most closely associated to that species although the pronotum is more as in *lugubris*.

Male. Head very slightly broader than long and a little longer than pronotum on median line; tylus rather long and slender with its sides parallel; impressions of vertex deep but ill-defined; pre-ocular and post-ocular tubercles obsolescent; antenniferous spines short, dull, very little divergent and without lateral teeth. Antennae more slender than front femora (3 : : 4), at thickest point (third segment) about three-fourths the width of an eye; longer than head and pronotum together (42 : : 40); first segment reaching a little beyond middle of tylus, second a little longer than interocular space plus one eye, third and fourth segments equal; proportion of segments one to four 5 : 19 : 9 : 9; first, third and fourth sub-equal in thickness, second one-half as thick as third at base, gradually thickened toward apex. Rostrum reaching anterior margin of mesosternum. Pronotum much as in *lugubris* but proportionately longer; widest well beyond middle but not so abruptly expanded posteriorly, lateral sides more nearly rectilinear, only slightly sinuate anteriorly; less convex than in *lugubris* with carinae ill-defined due to the very rough disk; lateral margins granulate, lacking the anterior teeth found in *abbas;* base even more distinctly roundly emarginate before scutellum than in *abbas*. Scutellum triangular, longer than pronotum (22 : : 19) with sides greatly elevated, much as in *funestus;* apex acute. Hemelytra just attaining apex of abdomen; corium reaching middle of fifth segment; exocorium lightly expanded, about as in *abbas;* mesocorium with very few indistinct cross-veins; endocorium with none. Connexivum rather broadly exposed. Fifth ventral segment distinctly shorter than sixth, less deeply notched on its basal margin than in *abbas* and almost evenly rounded on its anterior margin. Sixth segment with its anterior margin very evenly rounded. Genital segment large and convex.

Color brownish black with faint markings on the venter and legs a little lighter. Basal half of second antennal segment light brown, becoming dark toward apex. Hemelytra variegated. Veins of corium lighter brown, exocorium still lighter brown except at base. Clavus, endocorium, and mesocorium dark brown. Membrane hyaline, with large, quadrate brown spots between the veins. A few transverse veins moderately distinct.

Length 5.15 mm., width 1.97 mm.

Holotype, male, deposited on loan, Calif. Acad. Sciences, Puyallup, Washington, IX–17–'27, Wm. W. Baker, from the collection of Mr. Hanson sent for determination by Mr. A. T. McClay.

55. **Aradus cinnamomeus antennalis** Parshley

Additional hosts for this very widespread species are *Pinus ponderosa* (Lake Co., Calif., R. L. Usinger), *Pinus sabiniana* (Mt. Diablo, Calif., R. L. Usinger), *Pinus attenuata* (Ben Lomond, Calif., L. W. Saylor), and *Cupressus sargentii* (Cedar Mtn. Ridge, Alameda Co., Calif., F. H. Wymore).

57. **Aradus insoletus** Van Duzee

This is apparently a common species in California. A first record for Oregon may now be added: Myrtle Point, Ore., VI–25–'34, F. R. Platt.

57A. **Aradus leachi** Van Duzee

(Plate II, Fig. 57A)

Male. Similar to female except for smaller size, abdomen narrowed at base, rostrum reaching front coxae, hemelytra longer, reaching almost to level of apices of sixth abdominal segment, corium to posterior margin of fourth.

Genital segment strongly convex, lobes extending well beyond the curve of the abdomen, sides of cleft lightly sinuate at middle.

Length 5.1 mm., width (connexivum) 2.2 mm.

Described from a specimen taken by Dr. E. C. Van Dyke, Yosemite Valley, Calif., VII–8–'21, in collection of Calif. Acad. of Sciences.

MEZIRINAE

This subfamily has been, for the most part, neglected in our region by writers since the time of Champion's revision (1898). Blatchley added a species, *novella*, from Florida in 1924 and Van Duzee contributed some remarks on our Western species, "*moesta* Stål" and *reducta* n. sp. in 1927. Recent collecting by Mr. H. E. Hinton and the author in central Mexico has directed attention to this group and, although the true *moesta* has still not turned up, it becomes obvious that the Western species which Uhler (1876) called *Mezira moesta* Stål is not that species at all for several reasons as given below. A name is proposed for this species with corrected synonymy.

1. **Mezira moesta** Stål

Stål. 1862. Stet. Ent. Zeit., 23: 438.
Champion. 1898. Biol. Centr. Am. Rhynch., 2: 93, 102 (*Brachyrhynchus*).

Locality, Mexico.

2. **Mezira pacifica** Usinger, n. sp.
(Plate II, Figs. 1, 6 and 7)

moesta Uhler. 1876. Bull. U. S. Geol. Surv., 1: 323 (*Brachyrhynchus*).
moesta Van Duzee. 1917. Cat. Hem., p. 139.
moesta Blatchley. 1926. Heter. E. N. A., p. 323.
moesta Van Duzee. 1927. Pan-Pac. Ent., 3: 141–142.

Closely allied to *reducta* Van D., but easily distinguishable by means of the comparative characters given by Van Duzee (1927). Slightly smaller than Stål's *moesta*, male 7.46 mm. in length and 3.33 mm. broad, female, 7.69 mm. in length and 3.42 mm. broad. Inner apical margin of corium distinctly sinuate (not rounded as in *moesta*, see Stål and Champion, 1898). Antenniferous spines short and sub-acute, or even dull in some specimens (long and acute in *moesta*). Postocular tubercles distinctly surpassing eyes (not surpassing them in *moesta*). First segment of antennae distinctly surpassing apex of head (not at all or scarcely surpassing it in *moesta* Stål, 1862, apical process reaching to beyond middle of first antennal segment, Champion, 1898). Second segment about one-half length of third (two-thirds length of third in *moesta*). Van Duzee has very adequatley described this species elsewhere. Diagrammatic figures of the pronotum apex of corium, and female genitalia are given as an aid in placing this and *M. reducta* Van D.

Holotype, male, No. 3962, Calif. Acad. of Sciences, taken by the author in a rotten stump of *Pinus radiata*, Hills back of Oakland, Calif., IV–10–'27. Allotype, female, No. 3963, Calif. Acad. Sciences, same data as type. Paratypes, 3 females, same data as type, 1 female, IV–26–'27 and 3 females, XII–18–'26, Oakland Hills. Calif.

This species is said by Van Duzee (1927) to occur from Monroe, Washington, to the Mexican boundary. It occurs throughout this area, usually at elevations below 6,000 feet, and has been taken also at Troy, Idaho. It is common at the type locality and in the Berkeley Hills in the rotten stumps of Pine and in hibernation under the loose bark of Eucalyptus. Mr. E. P. Van Duzee first suspected that this species might have been misidentified by Uhler and called the author's attention to the discrepancies to be found upon comparing specimens with Stål's description.

3. **Mezira reducta** Van Duzee
(Plate II, Fig. 2)

Van Duzee. 1927. Pan-Pac. Ent., 3: 142.

This species is very close to *pacifica* but in a long series taken by E. G. Linsley and the author at the type locality and throughout the northeastern part of California as well as extensive material in the collections of the California Academy

of Sciences and the University of California from higher altitudes in Yosemite and elsewhere it proves to be constant in every detail as set forth by Van Duzee (1927). The species may be most easily distinguished by the female genital characters (Pl. II, Fig. 2), it being rather difficult, at times, to determine the males on antennae alone.

Mr. Linsley and the author took it in both small and large colonies, this gregarious habit being due to two factors, one, a necessity for a protected place for hibernation and, two, a common search for a fungus food. Except in cases which were obviously of the former type, *Mezira reducta* was always found under bark which also harbored colonies of *Zootermopsis nevadensis* or *Reticulitermes hesperus* at Hackamore. At first no significance was attached to this phenomenon, the supposition being that the association was merely one of chance. However, when specimens were found under bark in the very galleries of the termites, these galleries being sealed up until the bark was removed, it seemed that a real, although scarcely obligatory, termitophile might be added to our North American fauna.

Further evidence in favor of this supposition is the frequent occurrence of dirt-colored smears on specimens of this species. This material appears very similar both superficially and microscopically to termite excrement. A good series of this same species was taken by Prof. E. O. Essig, Little Yosemite Valley, Calif., 6,000 ft., V-18-'28, and was especially noted because of its occurrence in a Pine stump which was heavily infested with termites.

A tentative and purely hypothetical explanation for this phenomenon may be suggested on the basis of a paper by Hendee (1933) entitled "Association of the termites *Kalotermes minor*, *Reticulitermes hesperus*, and *Zootermopsis angusticollis* with fungi." In this paper it is shown that fungi are always associated with termitte colonies, many species having been isolated from each colony studied while fungi are rare in the neighboring wood. Also it is pointed out that many of these fungi are growing just up through the surface cells of the wood where they are eaten off by the termites, a fact which may account for the absence of visible fungus growth in the colonies in which the bugs were found.

4. **Mezira vanduzeei** Usinger, n. sp.

(Plate II, Fig. 3)

Runs to *neotropicalis* Champ. in Champion's key (1898) but differs from that species in the shorter third antennal segment and the scarcely constricted, apically convergent lateral margins and almost rectilinear posterior margin of pronotum.

Male. Head as long as broad; tylus reaching two-thirds the length of first antennal segment; antenniferous spines moderately long, broad at base, acute; post-ocular spines slightly exceeding eyes; surface very rough. Antennae sub-equal to length of pronotum and scutellum on median line; proportion of segments 1 to 4, 8 : 7 : 13 : 8 (12 : 10 : 16 : 9 in a female of *neotropicalis* before me from Chimaltenango Province,

Guatemala); first segment clavate, second and third cylindrical or slightly thickened apically, fourth elongate, pyriform. Pronotum almost twice as broad at base as long, approximately one-fourth narrower at anterior angles; lateral margins almost rectilinear, only lightly constricted at middle, anterior portion not dilated on each side into a broadly rounded lobe as in *neotropicalis* and not projecting forward; posterior margin almost rectilinear, slightly sinuate before middle of scutellum; surface flat, densely granulate. Apex of corium rounded. Connexivum comparatively smooth, with a few very short, curled brown hairs; lateral margins granulate, narrowed from base of fifth segment which is only slightly narrowed on basal four-fifths and rounded at apex; sixth segment slightly sinuate at sides, apical angles posteriorly produced, rounded. Terminal genital segment robust, cordate, lobes of first segment rather slender, short, reaching one-half the distance from apical angles of sixth connexival segment to apex of terminal genital segment. Venter pitted. Sternum granulate. Intermediate and posterior femora finely asperate, anterior femora more coarsely asperate. Antennae and legs lightly pubescent, apical antennal segment densely so.

Color piceo-ferrugineous, almost black on pronotum, scutellum, and base of head, and lighter, fusco-ferrugineous on antennae and legs, connexivum and venter light ferrugineous. Rostrum, coxae, trochanters, and tarsi ferrugino-testaceous.

Length 6.72 mm., width (connexivum) 2.77 mm.

Female. Similar to male. Connexivum narrowed from base of fifth segment, apices of sixth segment little produced, very broadly rounded, deeply and roundly emarginate at apex. Genital lobes rounded and not reaching level of genital valves and oviduct.

Length 7.15 mm., width (connexivum) 2.94 mm.

Holotype, male, No. 3964, Calif. Acad. of Sciences, Mt. Lemon, Santa Catalina Mts., Ariz., elev. 7,000 ft., VII–26–'24, E. P. Van Duzee. Allotype, female, No. 3965, Calif. Acad. of Sciences, same data as type. Paratypes, three males and two females, same data as type and two males and two females, Rustler Park, Chiricahua Mts., Cochise Co., Ariz., 8,000–9,000 ft., VII–27–'27, J. A. Kusche.

In some specimens the antenniferous spines are longer and more acute than in the type. This species is not to be confused with any other known to the author. It bears a superficial resemblance to *rugiventris* in size and shape but is very different from that species.

I take pleasure in dedicating this species to its collector, Mr. E. P. Van Duzee, who has done so much in this, as in other groups, toward the advancement of our knowledge of Hemipterology.

With the additions enumerated above we have seven species of *Mezira* reported from north of the Mexican boundary. These may be distinguished by means of the following key:

KEY TO THE SPECIES OF MEZIRA KNOWN TO OCCUR NORTH OF THE MEXICAN BOUNDARY

1. Small species, not over 5.5 mm 2
   Larger, at least 6.5 mm. in length 3
2. (1) Scutellum densely and evenly granulated, without elevation at base, the median carina obsolete or very faint. Eastern and Southern U. S. to Texas, Mexico and Cuba ..... **granulata** Say
   Scutellum with smooth, transverse elevation at base; disc divided by a distinct, entire, longitudinal, median carina. Florida ..... **novella** Blatchl.
3. (1) Apical margin of corium evenly arcuate. (Plate II, Fig. 8) 4
   Apical margin of corium sinuate. (Plate II, Fig. 7) 6
4 (3). Lateral margins of pronotum deeply notched before middle; anterior lobe narrower than posterior, its sides lamelately expanded laterally and anteriorly; carinae strongly elevated. Upper surface very rough, pubescent. Eastern, mid-western and southern U. S. to Texas and California. (Plate II, Fig. 4) ..... **lobata** (Say)
   Lateral margins of pronotum evenly or abruptly narrowed in their anterior half, but not with a distinct notch. Upper surface rather smooth, evenly granulate 5
5. (4) Oblong-ovate; lateral margins of pronotum rather abruptly narrowed in their anterior half and slightly projecting forward at the anterior angles; carinae moderately distinct. Mississippi, North Carolina, New Mexico, Nevada, California, and Texas. (Plate II, Figs. 5 and 8) ..... **emarginata** (Say)
   Sides not ovate, sub-parallel. Lateral margins of pronotum evenly narrowed anteriorly, rectilinear or only slightly sinuate at middle. Anterior angles not at all projecting in front. Arizona. (Plate II, Fig. 3) ..... **vanduzeei** n. sp.
6. (3) Genital plates of female prominent, sub-rounded, almost attaining apex of genital valves, the latter produced in a blunt angle beyond the oviduct. Basal antennal segment surpassing apical process by at least one-third its length, only moderately thickened in its apical two-thirds. Washington, Oregon, California, Idaho. (Plate II, Figs. 1, 6 and 7) ..... **pacifica** n. sp.
   Genital plates of female shorter, semi-circular in outline; genital valves scarcely exceeding the oviduct, about equalling the plates. Basal antennal segment scarcely surpassing apical process, very abruptly and strongly thickened in its apical two-thirds. California. (Plate II, Fig. 2) ..... **reducta** Van D.

Several additional new species and interesting records of this group are at hand from the Neotropical region and are described below.

5. **Mezira carinata** Usinger, n. sp.

Beset with very coarse granules. Pronotum divided by a deep transverse depression; anterior lobe with four distinctly elevated, coarsely granulate ridges, its antero-lateral margins lightly elevated, broadly dilated, projecting forward to beyond level of collar.

Female. Head as long as broad including eyes; beset with very coarse granules basally between the broad, oblique, smooth, deep impressions of vertex and with a single row of granules between these impressions and eyes; more closely and finely granulate on the tylus; antenniferous spines short, broad at base and flattened at top, sub-acute; tylus extending to apical one-third of first antennal segment, cleft at apex, its sides sub-parallel; post-ocular tubercles extending about to outer margins of eyes. Antennae as long as width of anterior lobe of pronotum; proportion of segments 1 to 4, 10 : 9 : 12 : 8, second, third, and fourth segments sub-equal in thickness to front tibiae, first

segment much thicker in apical two-thirds (5 : : 3). Rostrum not reaching posterior margin of head. Pronotum almost twice as broad as long; posterior margin lightly emarginate; lateral margins distinctly sinuate at middle; antero-lateral margins lightly elevated, broadly rounded and dilated, surpassing level of collar; lateral margins of posterior lobe rounded anteriorly, sub-parallel behind; anterior lobe much narrower than posterior lobe (4 : : 5) with four greatly elevated, posteriorly dilated longitudinal carinae, each with one or more rows of very coarse granules; posterior lobe sparsely and rather regularly coarsely granulate. Corium rounded at apex. Connexivum very rough, coarsely granulate with scattered ochraceous incrustated areas. Abdomen evenly, lightly rounded, more abruptly so from base of fifth segment. Sixth segment distinctly emarginate, its apices reaching level of base of sub-rounded genital plates which, in turn, do not reach apex of genital valves and oviduct. Beneath rugose, dull, with scattered incrustate areas on posternum and laterally on venter, the latter with the usual smooth spots. Anterior femora coarsely granular, intermediate and posterior femora less so. Antennae apically, tibiae, and tarsi covered with a short brown pubescence.

Color piceo-ferrugineous; impressions of vertex, disk of scutellum, corium, membrane excepting luteous area just behind apex of scutellum and triangular luteous areas behind outer apical angles of coria black; tarsi and coarse granules of head and anterior lobe of pronotum testaceous.

Length 8.72 mm., width (connexivum) 3.83 mm.

Male smaller with carinae and transverse depression of pronotum less distinct. Abdomen abruptly rounded from base of fifth segment. Sixth segment greatly elevated at middle, its apices lightly reflexed. Terminal genital segment cordate, lobes of first segment reaching to apical third of terminal segment. Color lighter, ferrugineous, where the female is piceo-ferrugineous.

Length 7.94 mm., width (connexivum) 3.5 mm.

Holotype, female, No. 3966, Calif. Acad. of Sciences, collected by Mr. H. E. Hinton and the author, Temascaltepec, Mexico, VI–2–'33. Allotype, male, No. 3967, Calif. Acad. of Sciences, and paratypes, two females and three males, same data as type.

Closely related to several of the Central American forms described by Champion. In dilation of anterior lobe of pronotum it approaches but does not equal that of *constrictus* Champ. Suggestive of both *neotropicalis* Champ. and *rugicornis* Champ. but with the anterior angles of the pronotum produced anteriorly. With the deep transverse groove of the pronotum found in *divisus* Champ. and recalling, somewhat, *rugiventris* Champ. which is smaller and pitchy black.

6. **Mezira rugiventris** (Champ.)

A male and two females which may be referred to this species were taken by H. E. Hinton and the author at "La Cumbre,"

elev. 9,000 ft., at the summit of the trail between Real de Arriba and Tisca, in the District of Temascaltepec, Mexico, VI–7–'33. They were collected beneath the bark of *Pinus montezumae*.

Champion's unique type, a male, was from Guatemala. The male before me differs only in possessing rather blunt antenniferous processes and this character is variable as the processes are acute in one of the females.

The females are somewhat lighter, fusco-ferrugineous, especially on the connexivum. The apical angles of the sixth segment are rounded, not produced with the sides sinuate as in the male. The sixth segment is evenly emarginate exposing a portion of first genital segment equal to diameter of genital lobes. These latter rounded, scarcely reaching level of tip of genital valves which only slightly surpass tip of oviduct.

7. **Mezira nigripennis** Usinger, n. sp.

Very light, ferrugino-testaceous, becoming darker on the corium and black on the membrane.

Male. Head as long as wide including eyes; tylus reaching to apical third of first antennal segment, cleft at apex; antenniferous spines short, blunt; post-ocular tubercles small, scarcely reaching outer margins of eyes; surface granular, the granules very large on middle of vertex and just within inner margin of eyes. Antennae as long as width of anterior lobe of pronotum, proportion of segments 1 to 4, 9 : 6 : 10 : 7; first segment abruptly thickened on apical two-thirds, second and third segments sub-cylindrical, the third more slender, fourth gradually thickened toward apex which is rounded. Rostrum short, not reaching posterior border of head. Pronotum twice as broad at base as long, distinctly narrower on anterior lobe than on basal lobe (31 : : 39); lateral margins subparallel on basal lobe, slightly convergent apically on anterior lobe; anterior angles rounded, expanded, projecting forward beyond level of collar; surface coarsely, sparsely granulate except in the depressions between the distinctly elevated callosities. Scutellum distinctly elevated along median carina. Outer apical angle of corium not rounded, apical margin evenly rounded. Connexivum granular, with a very short, inconspicuous brown pubescence; sides sub-parallel on second, third, and fourth segments, evenly rounded from base of fifth. Apical angles of sixth segment little produced, rounded. Sixth segment greatly elevated before genital segment. Terminal genital segment cordate; lobes of first genital segment very slender, extending but little beyond angles of sixth abdominal segment. Venter pitted. Sternum granular. Femora finely asperate, the anterior ones more coarsely so; legs covered with a short brown pubescence and sparsely, irregularly covered with a thin testaceous incrustation.

Color ferrugineous, becoming lighter, ferrugino-testaceous, on incrustate areas. Corium darker, fuscous, and membrane black. Tarsi testaceous.

Length 6.28 mm., width (connexivum) 2.77 mm.

Female. Similar to male but with the abdomen broader and more rounded. Genital plates short, sub-rounded, not reaching to level of genital valves.

Length 6.66 mm., width (connexivum) 2.94 mm.

Holotype, male, No. 3968, Calif. Acad. of Sciences, Horqueta, Paraguay, S. A., VII–25–'32, Alberto Schultze. Allotype, female, same data as type, in the author's collection.

This pretty species appears to be not closely related to any of our known species. Its closest relatives among the Brazilian species are *reuteri* Bergr., from which it differs in its lighter coloration and more constricted pronotum, *gradatus* Bergr., but is lighter and lacks the basal tubercles on the scutellum, *horvathi* Bergr., but lighter with the apical margin of the corium more rounded and the four callosities of anterior lobe of pronotum about equally prominent, and *ligneolus* Bergr. which is much smaller and otherwise different.

8. **Pictinus dominicus** Usinger, n. sp.

Near *breviceps* Champ. but larger with the anterior angles of the pronotum concolorous and connexivum alternate with transverse testaceous bands. Antennae uniformly dark, piceous, except at base. Sixth abdominal segment with apical outer angles distinctly projecting and with a laterally directed spiracle just beyond middle at margin, clearly visible from above.

Male. Head as long as broad; apical process small, much narrower than first antennal segment (2½ : : 3), and reaching a little more than half the distance to its tip, scarcely cleft at apex; antenniferous spines short, dull, their outer margins sub-parallel; post-ocular tubercles short, not reaching level of outer margin of eyes. Antennae sub-equal to length of pronotum and scutellum on median line; beset with short white hairs; segments 1 to 4 in proportion of 18 : 12 : 22 : 18; first segment very robust, as thick as front femora, abruptly narrowed and smooth on basal third, second segment more slender, slightly thickened apically, third sub-cylindrical, fourth pyriform, with long white hairs at tip. Pronotum almost twice as broad as long on median line (77 : : 40), granulate; transverse depression light but distinct; callosities of anterior lobe moderately elevated, separated by a deep sulcus; lateral margins lamellately expanded and distinctly elevated in anterior two-thirds, strongly narrowed anteriorly, lightly sinuate at middle and parallel on basal lobe; anterior angles rounded, distinctly projecting beyond anterior margin. Scutellum with a strongly elevated longitudinal carina at middle. Hemelytra with lateral expansions at base parallel, nervures of corium granulate, corium extending a little beyond middle of second abdominal segment. Membrane with a luteous fascia at extreme tip and along outer apical margin of corium, finely rugulose with a few ill-defined, anastomosing nervures at middle near the base. Abdominal margins sub-parallel on basal four segments, the fifth segment feebly sinuate laterally, its posterior angles lightly projecting, rounded. Sixth segment distinctly sinuate just before posterior angle which is obtusely

projecting, a spiracle arising before middle at the side and clearly visible from above. Genital lobes short, scarcely surpassing level of apical angles of sixth abdominal segment. Venter with spiracles distinctly projecting, located well within the lateral margins on all segments but the sixth.

Color ferrugineous, the antennae except for basal third of first segment black. Thicker, elevated portions of corium and membrane darker, fusco-ferrugineous. Connexivum alternated with transverse luteous bands which cover basal half of each segment except first. Sixth segment entirely luteous except for posterior margin. Terminal abdominal segment, postero-lateral portion of third and laterally on fourth and fifth ventral segments, legs except for coxae and trochanters and more or less on femora, laterally on ventral part of thorax, and eyes black.

Length 4.8 mm., width (connexivum) 2.02 mm.

Female. Very similar to male but darker throughout except for tibiae which are testaceous on front legs and testaceous basally on intermediate and hind legs. Genital plates prominent, sub-acute, not attaining level of apex of oviduct. Genital valves scarcely exceeding tip of oviduct.

Length 5.02 mm., width (connexivum) 2.02 mm.

Holotype, male, No. 3969, Calif. Acad. of Sciences, La Cavite, St. Domingo, III–5–'17, R. H. Beck. Allotype, female, No. 3970, Calif. Acad. of Sciences, same data as type and two paratypes, same data as type, in the collections of the California Academy of Sciences and the author.

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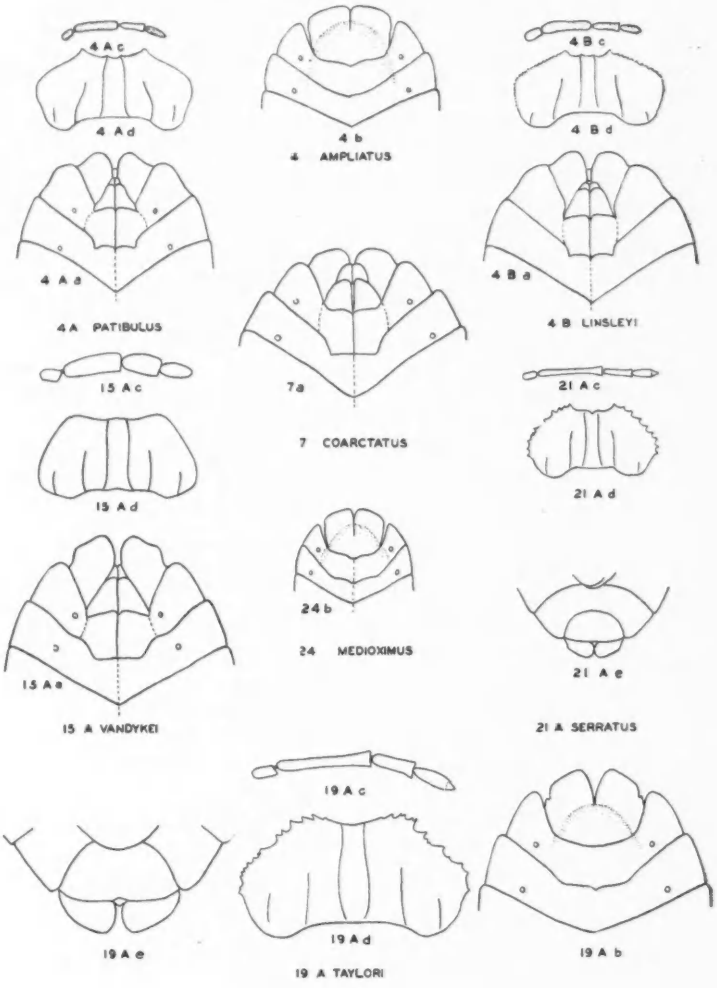
EXPLANATION OF PLATES

Numbering of figures follows that of Parshley (1921) for the Aradinae, each additional species being given the number of its nearest ally with a capital letter "A" or "B" added, and starts anew for the Mezirinae on Plate II. The lettering used in connection with the figures of the various species follows that used by Parshley, e. g.:

a. Ventral view of the posterior abdominal structures in the female
b. The same in the male
c. Antenna
d. Pronotum
e. Dorsal view of the posterior abdominal structures

AMERICAN SPECIES OF ARADUS



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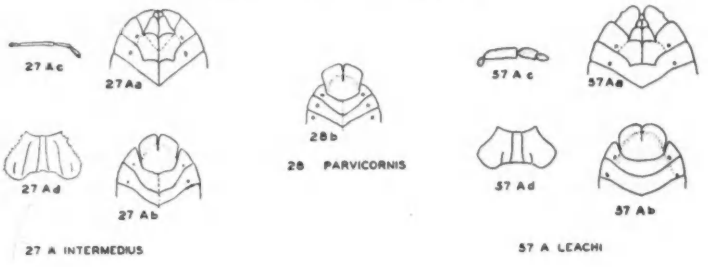
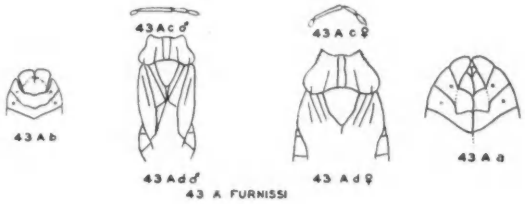
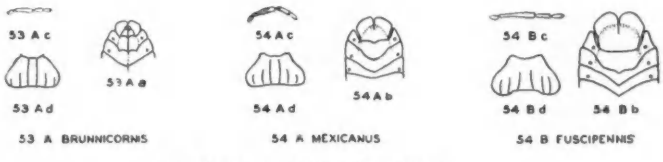
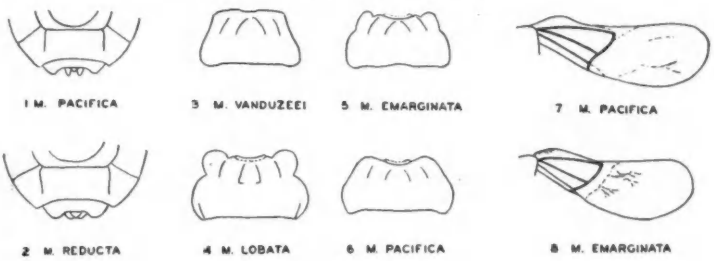






AMERICAN SPECIES OF MEZIRA



THE GENUS ODONTOMYIA IN AMERICA NORTH OF MEXICO
(Diptera, Stratiomyidae)

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Forty years ago, Mr. C. W. Johnson monographed the genera *Odontomyia* and *Stratiomys* for North America, and separated them, as European authors had done and as American authors have continued to do to the present day, on the basis of the comparative length of the first and second antennal segments. Today, Johnson's work, admirable as it was, has become antiquated in the light of more modern research. New species have been added and, to an extent, concepts of old species have been changed. The present work, based on several thousand specimens from the collections of institutions scattered throughout the United States and Canada, will, I hope, straighten out several perplexing questions and facilitate identifications in this genus. An attempt is made, furthermore, to indicate relationships through the recognition of species groups.

The concept of the genus *Odontomyia*, as presented in this paper, is a new one, brought about by the removal to other genera of species formerly placed here. The reasons for such an action will be set forth more clearly in a forthcoming paper on the classification of the Stratiomyinae. Let it suffice here to state that the keynote to such a classification consists of the recognition of Enderlein's genus *Labostigmina*, which is redefined, and the relegation to a position of secondary importance of the old criterion of separation, namely, the comparative length of the first and second antennal segments.

As defined here, the genus *Odontomyia* may be characterized as follows: The head is approximately as wide as the thorax; the eyes are moderately large, sub-contiguous in the male, widely separated in the female. The face is moderately receding or slightly prominent or tuberculate, the prominence not extending forward beyond the apex of the first antennal segment. The occipital orbits are of moderate width in the female, narrow in the male. The antennae are three-segmented, short, and divergent; the first segment is not more than one and one-half times as long as the second; the third is six-annulated, the fifth and sixth annuli forming a rather poorly defined style, the fifth annulus sometimes obscure, and usually the shortest of the six. The proboscis is moderately long; the labella slender. The scutellum is distinctly spined, the spines being approximate, that is, situated on the

median third of the scutellum. The wing venation is typical of the Stratiomyinae; vein R_4 present or wanting; the branches of the media, especially M_3, much reduced and weak, except in the *truquii* and *dorsalis* groups. The abdomen is flattened, the venter typically unicolorous and pale. Sexual dimorphism is the rule rather than the exception.

Several terms used in the keys and descriptions may need special interpretation. These are:

The *mid-frontal suture* is the suture extending from the apex of the ocellar triangle to the base of the antennae; it is the anterior arm of the epicranial suture of Peterson (1916).

The *facial prominence* is the prominence below the base of the antennae.

The *facial depression* is the depression produced by the union of the oral margin with the face and genae.

An investigation into the life histories of these insects would be a fertile field for research, as comparatively little has been done along this line. Hart (1895), Malloch (1917), and Johannsen (1922) describe or key the immature stages of six species of American *Odontomyia*, two of which were not identified. I have examined the poorly preserved puparium of a seventh species (*O. truquii* Bell.); it has the apical abdominal segment at least four times as long as wide, and resembles a *Stratiomys*. The characters were too poorly defined to attempt to run it in Johannsen's key. So far as is known, the larvae are aquatic, and feed on small organisms, both animal and plant. All northern species are single-brooded, though collecting data would indicate two broods in the Gulf states. The adults frequent umbellifers, composites, and other flowers in the vicinity of water.

There are apparently several centers of distribution in the United States. The Pacific coast has its own representative species which rarely extend east of the Rockies. There are several species that belong characteristically to the higher Rockies. A large number of species seems to have originated along the upper Atlantic seaboard of New England and the Canadian provinces; some of these are quite narrowly confined to that region, while others have extended broadly westward and southward. The *dorsalis* group appears to have originated in the West Indies or the Gulf States, but has spread westward and northward. *O. truquii* Bell. has a remarkably wide distribution; originally described from Mexico, it has been recorded from a large part of the United States and Canada. As might be expected, several varieties have been recognized.

I am indebted to many individuals and institutions that have aided me in this work: To Dr. C. H. Curran and the American Museum of Natural History, to the United States National Museum, the Canadian Entomological Branch, the Los Angeles City Museum, the San Diego Museum of Natural History, the University of Rochester, the University of Minnesota, Dr. C. L. Fluke and the University of Wisconsin, the University of Texas, the University of Kansas, the University of Idaho, Brigham Young University, the University of Colorado, the South Dakota State College, Kansas State College, Purdue University, Colorado State College, Utah State College, and the California Citrus Experiment Station of Riverside; also to Messrs. R. H. Painter, C. W.

Sabrosky, C. S. Brimley, H. J. Reinhart, J. W. Monk, Joseph Wilcox, Earl Pritchard, Frank R. Cole, Charles Hicks, Kenneth Maehler, S. W. Bromley, and others. Without the generous loan of specimens on the part of these institutions and individuals, such a work as this would have been impossible.

KEY TO SPECIES

Eyes contiguous.....males
Eyes widely separated.....females

Males

1. Radio-medial cross-vein wanting; media with three branches, all of which extend almost to the posterior wing margin..... 2
   Radio-medial cross-vein present; at least the third branch of the media much abbreviated..... 6
2. Face prominent below the base of the antennae; branches of the media weak; length, 10 mm. or less, rarely up to 11 mm..... 3
   Face receding below the antennae; branches of media strong; length, 12 mm. or more, usually 14 to 16 mm..... 5
3. Oral margin and face pale..... 4
   Oral margin black; face brown.....**vertebrata** Say
4. Sides of mesonotum wholly pale, at least behind the suture...**trivittata** Say
   Sides of mesonotum black behind the suture, at most the supra-alar regions pale.....**dorsalis** Fabr.
5. Disc of mesonotum with two pale spots; femora yellow, the apices sometimes rusty or brownish; the black of the abdomen not reaching the margin, but sometimes represented by small black marginal spots, **truquii** Bell
   Disc of mesonotum wholly black; anterior femora at least in part blackish; the black of the abdomen attains the lateral margins at the base of the segments.....**varipes** Loew
6. Eyes clothed with conspicuous pile.....**hirtocculata** n. n.
   Eyes bare..... 7
7. Antennal style fully as long as the first antennal segment and gradually tapering to a sharp point.....**microstoma** Loew
   Antennal style definitely shorter than the first antennal segment, and, if sharp, not tapering to a point..... 8
8. Face prominent, the antennae situated at the apex of the prominence, **nigerrima** Loew
   Face receding; or if prominent, the apex of the prominence below the base of the antennae..... 9
9. Femora black, the apices often pale.....10
   Femora wholly yellow, at most reddish or brownish.....14
10. The pale markings on the second abdominal segment reaching toward and attaining, or nearly attaining, the base of the segment.....11
    The pale markings on the second abdominal segment not encroaching upon the basal half of the segment, usually narrower and linear.....12
11. Antennae as long as anterior femora; R_4 usually wanting; strong veins yellow.....**interrupta** Loew
    Antennae much shorter than anterior femora; R_4 strong; strong veins brown.....**colei** n. sp.
12. Face unusually broad; the oral margin pale; vein R_4 distinctly present, **pilosa** Day
    Face of moderate breadth; the oral margin black; vein R_4 usually wanting.....13
13. Pile of entire body chiefly silvery or grayish; pale abdominal markings narrow, almost obsolete.....**painteri** n. sp.
    Pile of entire body chiefly yellowish to golden; pale markings of abdomen distinct and conspicuous.....**hoodiana** Bigot
14. Face above the depression wholly yellow, the frontal triangle sometimes black.....15
    Face above the depression and the frontal triangle wholly black.....20

15. Lateral margin of mesonotum wholly green or yellow.....**cincta** Oliv.
Lateral margin of the mesonotum black, the posterior calli sometimes pale.....16
16. Abdomen beyond the first segment wholly pale.....**aldrichi** Johns.
Abdomen beyond the first segment with distinct black markings.....17
17. Facial depression black.....**occidentalis** n. sp.
Facial depression yellow.....18
18. Inner occular orbits strongly bowed; the width of the face across the oral margin greater than the distance from the upper angle of the oral margin to the base of the antennae.....**tumida** Banks
Inner occular orbits almost straight; the width of the face across the oral margin about equal to the distance from the upper angle of the oral margin to the base of the antennae.....19
19. Abdominal band as wide on the second and third segments as on the fourth; in some cases the pattern on the second and third segments is broken, so that the width must include the separated marginal spots, **arcuata** Loew
Abdominal bands definitely narrower on the second and third segments than on the fourth, and without separated marginal spots...**alticola** James
20. Oral margin yellow.....21
Oral margin black, rarely reddish to brown.....25
21. Face retreating below the antennae.....22
Face with a keeled prominence below the base of the antennae.....24
22. Dorsum of thorax wholly black; abdominal band with even edges, **americana** Day
Humeri and posterior calli yellow; abdominal band broad, deeply incised.....23
23. Apex and lateral margin of scutellum yellow.....**flava** Day
Yellow of scutellum not extending beyond the spines.....**idahoensis** James
24. The black abdominal band almost as wide as the abdomen on the third segment.....**confusa** n. sp.
The black abdominal band not more than one-third the width of the abdomen on the third segment.....**inaequalis** Loew
25. Apex of scutellum broadly yellow.....**discolorata** n. sp.
Apex of scutellum with a narrow yellow margin which does not extend laterally beyond the spines.....26
26. Anterior basitarsi fringed below with pile which is distinctly longer than the width of the segment; antennal style sharp; abdomen green, with a black dorsal stripe.....27
Anterior basitarsi with ordinary pile which is no longer than on the middle or hind basitarsi.....28
27. Face evenly retreating.....**borealis** n. sp.
Face tuberculate.....**pilimana** Loew
28. Abdomen black with interrupted yellow posterior bands on segments two, three, and four.....**pubescens** Day
Abdomen green or yellow with a black dorsal band.....29
29. Third segment of antennae black; antennal style blunt.....**virgo** Wied.
Third segment of antennae yellow; antennal style sharp..**hydroleonoides** Johns.

FEMALES

1. Radio-medial cross-vein wanting; media with three branches, all of which extend almost to the posterior wing-margin..... 2
Radio-medial cross-vein present; at least the third branch of the media much abbreviated..... 7
2. Face prominent below the base of the antennae, and marked at least with a small black spot on either side; branches of media weak; length, 10 mm. or less, rarely up to 11 mm..... 3
Face receding to the oral margin, and wholly pale; branches of media strong; length, 12 mm. or more, usually 14 to 16 mm..... 6
3. Disc of mesonotum with two pale vittae, in addition to the lateral vittae, **trivittata** Say
Only the lateral margins of the mesonotum pale..... 4

4. Abdomen with a row of black spots which extend definitely less than half the length of the segments ..... **dorsalis** Fabr.
   Abdominal black spots almost or quite the length of the segments 5
5. Head wider than the thorax; femora each with a black band on the penultimate fourth ..... **bellula** n. sp.
   Head approximately the width of the thorax; femora wholly yellow, ... **vertebrata** Say
6. At most the narrow base of the scutellum black; antennae in large part clearly reddish; the inner arms of the first pair of abdominal spots usually enlarged; labellae but little tapering beyond the middle. . **truquii** Bell.
   The black base of the scutellum almost always convexly produced in the middle; the spots seldom emit an arm toward the middle of the second segment, and, if so, it is short and acute; labella strongly tapering to something of a point from the middle ..... **varipes** Loew
7. Eyes clothed with conspicuous pile ..... **hirtocculata** n. n.
   Eyes bare 8
8. Antennal style fully as long as the first antennal segment and gradually tapering to a sharp point ..... **microstoma** Loew
   Antennal style definitely shorter than the first antennal segment and, if sharp, not tapering strongly to a point 9
9. Mesonotum with lateral yellow markings extending at least for a short distance in front of the suture 10
   Mesonotum wholly black in front of the suture, the humeri sometimes yellow 11
10. The black abdominal markings extending laterally to the margin of the abdomen, or nearly so ..... **cincta** Oliv.
    The black abdominal markings forming a narrow median stripe, ... **discolorata** n. sp.
11. Face prominent, the antennae situated at the apex of the prominence, ... **nigerrima** Loew
    Face receding; or, if prominent, the prominence below the base of the antennae 12
12. Posterior femora wholly, or at least half, black 13
    Posterior femora yellow or at most reddish 16
13. Vein R_4 present 13a
    Vein R_4 absent 14
13a. Front wholly black; head unusually wide ..... **pilosa** Day
    Front with yellow markings along the mid-frontal suture and to each side of the ocellar triangle; head of normal width ..... **colei** n. sp.
14. Pile of thorax tomentum-like, none or very little of it erect. . **interrupta** Oliv.
    Pile of thorax erect; but little appressed tomentum 15
15. Front wholly black; abdomen dorsally with considerable short, erect black pile, but with very little pale pile; pale abdominal markings narrow, but distinct ..... **hoodiana** Bigot
    Front usually marked with yellow along the mid-frontal suture, rarely wholly black; abdomen dorsally with considerable grayish or white pile and tomentum, but with little black pile; abdominal markings very narrow, often evanescent ..... **painteri** n. sp.
16. Head chiefly black, more or less marked with yellow; dorsum of thorax wholly black, at most the posterior calli yellow 17
    Head yellow, marked with black; sides of mesonotum yellow at least along the wing bases; humeri yellow 23
17. Front and vertex reddish yellow, except for the ocellar triangle and the region around the base of the antennae ..... **hydroleonoides** Johns.
    Front and vertex black, at most yellow along the mid-frontal suture and to each side of the ocellar triangle 18
18. Abdomen wholly green beyond the second segment, at most somewhat discolored ..... **aldrichi** Johns.
    Abdomen with prominent black markings 19
19. Abdomen black in ground color, with pale transverse linear markings at the posterior margins of the segments ..... **pubescens** Day
    Abdomen pale in ground color, with a dorsal black stripe which may, however, be almost the width of the abdomen 20

20. The pile beneath the front basitarsi as long as the width of the segment, or nearly so; style of antennae twice as long as wide, acute; front usually with a pair of yellow spots below the ocelli.....21
The pile beneath the front basitarsi of ordinary width; style of antennae not over one and one-half times as long as wide, blunt; front almost wholly black.....**virgo** Wied.
21. Pubescence of thorax golden (east of Rockies).....22
Pubescence of thorax white-grayish, not golden or brassy (Pacific Coast States).....**americana** Day
22. Face tuberculate below antennae.....**pilimana** Loew
Face receding below antennae.....**borealis** n. sp.
23. Face with a median black or brown vitta which widens out just above the oral margin.....24
Face wholly green or yellow, or marked with black other than along the mid-facial line.....25
24. Abdominal bands from half to two-thirds the width of the segments, those of adjoining segments never connecting.....**inaequalis** Loew
Abdominal bands almost the width of the segments, those on adjacent segments often connected.....**confusa** n. sp.
25. Abdomen green with a narrow black vitta which is at most not more than one-third the width of the abdomen.....**discolorata** n. sp.
Abdomen with prominent black markings which are almost or quite the width of the segments.....26
26. The black markings on the third abdominal segment semi-elliptical, broadest at the middle of the segment.....27
The black marking of the third abdominal segment with a biarcuate posterior margin, as broad or nearly as broad laterally as medially.....28
27. Scutellum black basally; the black bands of the fourth and fifth segments broad, sometimes contiguous.....**occidentalis** n. sp.
Scutellum wholly yellow, sometimes black-pilose basally; the black bands of the fourth and fifth abdominal segments never contiguous, **alticola** James
28. Face in lateral profile extending forward as far as width of the eye; abdominal bands never contiguous.....**tumida** Banks
Face in lateral profile extending forward much less than the width of the eye; abdominal bands often contiguous.....**arcuata** Loew

Odontomyia Meigen, 1803

Eulalia Meigen 1800; *Odontomyina* Enderlein 1930.

Type, *Musca hydroleon* Linn., by designation of Westwood, 1840.

Five distinct species groups occur in our region; the group of *O. hydroleon* is not nearctic, unless *O. discolorata* belongs here. The groups may be distinguished as follows:

1. Vein r-m wanting; branches of media long..... 2
Vein r-m present; branches of media abbreviated..... 3
2. Face tuberculate; smaller species.....**dorsalis** group
Face receding; larger species.....**truquii** group
3. Pleura, humeri, and supra-alar regions marked with yellow, at least in the females.....**arcuata** group
Mesonotum and pleura wholly black..... 4
4. Abdomen black in ground color, with pale triangular or linear markings at the apices of the segments.....**hoodiana** group
Abdomen yellow in ground color, with or without a median black stripe.....**virgo** group

The **truquii** group

Large, predominantly yellow flies; the fifth annulus of the third antennal segment more or less obscure, the sixth forming a distinct style; the face receding to the oral margin; the dorsum of the thorax distinctly marked with yellow; spines of scutellum large, more distant than usual in the genus; vein R_4 present; cross-vein r-m absent, the discal cell resting upon the radius; the media with three strong branches which extend almost to the posterior wing margin. This group is strictly American and is represented by two variable species in the nearctic region.

Odontomyia truquii Bellardi, 1861

O. megacephala Loew 1865 (syn. Johnson); *O. binotata* Loew 1865; *O. bicolor* Day 1882 (syn. Johnson).

Female: Head somewhat broader than the thorax, pale in ground color; occipital orbits broad, yellow; occiput largely yellow, black near the center. Vertex with a black band that includes the ocellar triangle and extends laterally on each side to the eyes; the front crossed by an irregular black band; this band and that of the vertex usually connected twice near the middle of the front to inclose a circular or heart-shaped spot. Face separated from the broad inner-occular orbits by a definite groove; chiefly pale. First and second antennal segments subequal, pale; the third black. Pile of head short, moderately sparse, mostly pale; usually some black pile on the front. Dorsum of thorax black, broadly margined laterally with yellow; the disc of the thorax with two large yellow spots which connect by means of narrow bands with the margins, anteriorly; pleura and pectus pale; scutellum and spines pale. Thorax clothed with moderately long and dense pale pile; this is longest on the pleura; it is mostly erect or semi-erect, though there is some appressed pile on the dorsum. Abdomen pale in ground color; first segment wholly black dorsally; the second to fifth with transverse bands which connect with the bands on the adjacent segments; these bands are broadest basally, and attain the lateral margins of segments three to five; segment five largely black, with broad yellow lateral and apical margins. Venter green. Legs yellow; the femora, except bases, tibiae and tarsi with a reddish brown tinge; the apices of the tibiae and basitarsi and all of the remaining tarsomeres may be blackish. Hind tibiae distinctly flattened on the apical half; the middle tibiae somewhat flattened apically. Wings hyaline; veins strong, yellow. Length, 12–14 mm.

Male: Ocellar triangle long, largely black, yellow on the posterior border, this yellow extending for some distance onto the occiput; the occiput chiefly black on the upper, yellow on the lower, half; frontal triangle variably black or yellow; face yellow; the occipital orbits yellow on the lower half and distinct, but obliterated above by the eyes, which encroach somewhat upon the occiput. Sides of dorsum of thorax broadly yellow; the disc with two yellow spots which are much smaller than in the female, and isolated. The abdominal markings are confined to the median half of the segments and form a continuous band which terminates at about the middle of segment five. Otherwise as in the female.

Type, Bellardi Collection; from Mexico.

Distribution: The Great Lakes region to Manitoba, Oregon, California, Mexico, and Texas. Ind.: Tippecanoe Co. (H. O. Deay). Mich.: Douglas Lake (H. B. Hungerford). Ontario: Strathroy (Hudson). Manitoba: Aweme (R. M. White). Ill.: Algonquin. Wis.: Common. Minn.: Common. Iowa: Emmet County (Jaques). S. D.: Common. Nebr.: Common. Kans.: Common. Okla.: Beaver, Alfalfa, and Ford. Tex.: Common. Colo.: Common. N. M.: Common. Ida.: Parma (C. Wakeland); Kiler (Duncan). Utah: Common. Ore.: Common. Nev.: Mt. Wheeler (V. M. Tanner). Calif.: Common. April to June in the south; June to August in the north. Records from Riverside, Calif. (Timberlake) from March 26 to May 26 and from Aug. 16 to Nov. 4 indicate the presence of two annual broods; there are perhaps also two annual broods in southern Texas and Mexico.

Life History: A puparium of a specimen reared by C. W. Sabrosky resembles, in many ways, the puparia of *Stratiomys*, though it is too poorly preserved to describe. The apical segment is at least as long as the two preceding segments, as in *Stratiomys*. Adults have been taken on *Helianthus* spp.

Odontomyia truquii innotata Curran, 1927

The black markings of the abdomen and the black background of the thorax are more extensive than in the typical subspecies, in both sexes. In the female the pale spots on the dorsum of the thorax are wanting or small and isolated; in the male they are wanting. Sometimes the base of the scutellum is narrowly black. In the specimens I have seen, the head, in the females, is distinctly wider than the thorax.

Type, Riding Mtns., Man.; in the Canadian National Collection.

Distribution: Mich.: Constantine; Douglas Lake (Hungerford). Manitoba: type. Wyo.: Yellowstone National Park (Tanner, Frank Lutz); Green River (Lutz). Colo.: Common. Utah: Common. Ariz.: (Snow). Ore.: Dixie (J. Nottingham). Calif.: San Diego Co., Altadena, Redlands (Frank Cole); Concord (M. C. Lane). Apparently much more western in general distribution than the typical subspecies.

Odontomyia truquii currani James, 1932b

Similar to *innotata;* but the dorsum of the thorax is black laterally in the male, at least before the suture, and the base of the scutellum is black and clothed with moderately dense, erect, black hair in both sexes.

Type, Kits Peak, Rincon, Baboquivari Mts., Ariz.; in the American Museum of Natural History.

Distribution: Ariz.: type; Huachuca Mts., (R. H. Beamer). Texas: Austin (R. H. Painter); Donna (J. W. Monk).

Odontomyia varipes Loew, 1865

O. alberta Curran 1922 (syn. Curran 1927).

Similar to *O. truquii;* it differs chiefly in the characters given in the key. There is much more black on the legs, as a rule, and the abdominal markings are different. The black markings of the scutellum are diagnostic.

Type, from "Carolina"; in the Museum of Comparative Zoology, Cambridge, Mass.

Distribution: Apparently more northern and eastern than *O. truquii;* recorded by Curran (1927) from Alberta, Manitoba, and Ontario.

The **dorsalis** group

As in the preceding group, the radio-medial cross-vein is absent and the branches of the media are long. The flies of this group are much smaller, however; the face is prominent or tuberculate; the branches of the media, though distinct, are weak; and the discal cell is oblique, rather than erect. This is a group of variable species, some of which are apparently of wide distribution.

Odontomyia trivittata Say, 1829

O. tritaeniata Bellardi 1859.

Female: Head pale; ocellar triangle and a small round spot on each side of the face, black; a spot to each side of the antenna, another to each side of the ocellar triangle, and an irregular transverse band on the front, all rather indefinitely outlined, a pale, rusty brown. Vertex somewhat flattened, the ocellar triangle tuberculate. The suture separating the front and face prominent, groove-like. Face tuberculate below the antennae, thence sloping to the oral margin. Head almost lacking in pile, except on the genae, where it is moderately long and pale, and on the front, where it is extremely short, erect or semi-erect, and black. Proboscis pale; labella black. First and second antennal segments yellow, the third black; the fifth annulus small, the fifth and sixth forming a distinct, curved style. Thorax black dorsally with broad pale lateral margins and two median yellow stripes on the disc, which are somewhat variable in extent, but which always extend from the anterior margin to the base of the scutellum; the vestiture consists of dense tomentum and no erect pile. Scutellum pale. Pleura pale; pectus green; the vestiture of the pleura and pectus consists of semi-erect pale hairs which are densest on the pectus. Abdomen pale; segments two, three and four with black median triangles at the bases of the segments which taper apically and may or may not connect briefly with the triangles of the following segments; segment one with a median apical spot which connects broadly with the triangle on segment two. Segment five wholly pale; venter pale. Abdomen clothed both ventrally and dorsally with appressed pile which is, for the most part, black, but which tends to become pale toward the lateral margins and on segment five dorsally; this pile is much denser dorsally than ventrally. Legs pale, the tarsi

somewhat darkened. Wings clear hyaline, the strong veins yellow. Length, 8–10 mm.

Male: Eyes broadly contiguous and extending slightly over the occiput above; head wholly pale. Dorsum of thorax pale laterally, but lacking the pale stripes of the disc. Pile and tomentum of thorax longer than in the female; the dorsum with some semi-erect pile laterally. Abdomen with a narrow black median line which widens out considerably on the fourth segment and ends at the base of the fifth. Otherwise as in the female.

Type, lost. Described from Mexico.

Distribution: Wis.: Madison, June 2–27 (Fluke). Minn.: St. Louis Park, Hennepin Co., June 16, 1922 (Nichol). Fla.: Childs, July 6, 1930 (R. H. Beamer) and Wildwood, Aug. 2, 1930 (Paul Oman). Texas: Austin, Feb. 5, 1921 (R. H. Painter) and Oct. 1, 1899 (W. M. Wheeler). Mexico: Joyntla, Mor., Aug. 6, 1903.

Considerable variation occurs in this species. The extent of the black pile and of the black markings of the abdomen is variable, in both sexes. The third antennal segment may be concolorous with the first and second, or darker. Several males from Mexico have the base of the scutellum black. The black and pale pile on the scutellum may appear in varying amounts. *O. tritaeniata* may not be an absolute synonym, but a variety or subspecies.

Odontomyia trivittata leucogaster James

O. leucogaster James 1933.

In this subspecies, the abdomen is wholly pale or almost so, at most with darkened regions at the base of the segments, in a median line; the antennae are yellow except for a black band on the fourth annulus of the third segment; the scutellum in the male is brownish basally and yellow apically, the color gradually merging from one to the other; the black on the pectus of the male encroaches somewhat upon the pleura.

Type, Galveston, Texas; in the Snow Entomological Collection, University of Kansas.

Distribution: Texas: Donna (Monk); Brownwood (Painter); Roosevelt (Painter); Hidalgo Co. (Beamer). June to August. Mexico: Topila, V. C. (C. W. Sabrosky).

Odontomyia dorsalis Fabricius, 1805

Much similar to *O. trivittata* Say; the markings of the thoracic dorsum are the only reliable means of separating the species, and there is some intergradation even here in the males. This species differs from *trivittata* as follows:

Female: The brown markings on the head are narrower and more distinct. Third antennal segment brown. Pile of thorax yellowish to golden. Disc of thorax wholly black; the lateral margins broadly pale for their entire length. Abdominal markings similar to those of *O. trivittata*, but more reduced, and limited, in the specimens examined, to

the bases of the segments, except for the apical spot on segment one. Middle and hind femora each with a brown preapical annulus. Length, 8–10 mm.

Male: Thoracic dorsum wholly black except for the posterior calli and the wing bases directly in front of the calli; this pale region does not as a rule approach the suture.

Type, "West Indies;" lost?

Distribution: Fla.: Miami, June 30, 1923. Texas: Donna, Oct. 15, 1933 (Monk). Cuba: Common. San Domingo: 1 specimen.

Odontomyia vertebrata Say, 1824

Female: Head pale, with brownish or blackish intricate markings on the front and vertex which are quite characteristic of this species; ocellar triangle black; from the ocellar triangle on each side a brown or blackish band extends laterally on the vertex; this band does not reach the eyes, but bends downward onto the front and terminates in the inner occular orbits about one-third of the way down; another band of similar color extends from the ocellar triangle along the mid-frontal suture half way to the antennae; this combined pattern of the front and vertex has somewhat the appearance of an inverted epsilon. The lower part of the front is further marked with a zigzag line appearing like an inverted W; this connects medially and laterally with a black spot at the base of the antennae, thus inclosing two pale spots above the antennae. The black spot at the base of the antennae extends laterally almost or quite to the eyes, and sends a rather poorly defined projection downward onto the face, to connect with a black spot to each side of the facial prominence. Face, oral margin, and cheeks variously maculated with pale brown. Antennae yellow; the first and second segments sometimes blackened basally; the third sometimes wholly black. Proboscis black, the labella rather slender. Pile of head very short and sparse; yellow and appressed. Thorax black dorsally; the lateral margins yellow behind the suture and at least briefly before the suture; a yellow projection may extend anteriorly on each side to the humerus, thus cutting off a black lateral spot just behind the humerus; humeri yellow. Pectus black, with large extensions of this black region encroaching upon the mesopleura; pleura otherwise yellow, with somewhat variable blackish or brown maculations. Scutellum yellow; spines short, blunt, yellow. Thorax clothed with a moderately dense yellow appressed tomentum and a little erect pile on the pleura. Abdomen yellow in ground color but in actuality usually largely black; the abdominal markings occur as black trapezoids on segments two to four, the bases of the trapezoids being basad of the segments and connected more or less broadly with the markings of the preceding segments; the yellow runs in somewhat at the sutures. Segment five with a black marking on the basal third; segment one wholly black except laterally. Venter green. Legs yellow, the tarsi darkened apically. Wings as in *trivittata*. Length 7–9 mm.

Male: Face yellow; frontal triangle and oral margin black; face somewhat tuberculate; occiput and ocellar triangle black; occipital orbits evanescent. Thorax black, the posterior calli yellow; pleura and ster-

num with a few pale maculations; scutellum black, broadly margined laterally and apically with yellow. Thorax with rather uniform moderately long and moderately dense gray pile, and, dorsally, with yellow tomentum; scutellum largely black-haired. Abdomen marked as in the female, but with the trapezoids much narrower, not more than one-third the width of the abdomen, and forming a dorsal line that terminates on the basal third of the fifth segment. Otherwise as in the female.

Type, "Northwest Terr."; lost.

Distribution: Common in the upper Atlantic Seaboard and Great Lakes region: Que., Ont., Me., Conn., Mass., N. Y., N. J., Mich., Ill., Wis., Iowa, S. D. Recorded by Johnson (1895) from Pennsylvania. Mo.: Kansas City (F. Rogers); Atherton. Man.: (W. J. Brown). Colo.: Ft. Collins (K. Maehler). June to August.

This species is subject to considerable variation. The markings on the front and vertex of the female may be very pale, and may be somewhat interrupted along the midfrontal line. The abdominal markings may be interrupted at the apices of the segments. In one specimen from Manitoba, these interruptions are broad and the trapezoids are almost bisected by pale median projections. The width of the trapezoids varies from less than half to almost the complete width of the abdomen.

Odontomyia bellula, new species

Female: Head broader than the thorax; ground color yellow, marked with black as follows: Vertex with a transverse black band which includes the vertical triangle and extends laterally almost to the eyes; front, at its middle, with a transverse band, interrupted medially, that extends laterally to the eyes; a narrow transverse band on the front just above the base of the antennae and a broader one just below; these two are quite variable in form and extent, and may each be twice interrupted; but they include the region at the base of the antennae and the facial prominence. Facial depression on each side with a black spot which extends somewhat onto the oral margin. Face moderately prominent above the oral margin. Eyes somewhat angular, bare. Proboscis black; palpi pale; labella long and slender. First and second antennal segments subequal, yellow; the third slightly less than twice the combined lengths of one and two; style short, straight, pointed; third segment, including style, brownish black, somewhat paler basally. Pile of head moderately sparse, wholly pale. Thorax black dorsally with broad yellow margins; humeri and scutellum yellow; pleura yellow; sternum black; vestiture of thorax a semi-erect yellow pile, and on the dorsum, golden tomentum. Halteres green. Abdomen yellow; a black band extending from the apex of segment one to the base of segment five; this band expanded basally on segments two, three, and four, and gradually widening from the anterior to the posterior end; at its greatest expansion it is about half the width of the abdomen. Venter wholly yellow. Pile sparse, wholly pale. Legs yellow except the coxae and the penultimate fourth of the femora, which are black; tarsi darkened. Venation as in *O. trivittata*. Length, 6–7 mm.

Holotype, female, 6 mi. N. of Brownsville, Texas, July 18. 1933 (R. Nabours and C. W. Sabrosky); in the author's collection. Paratype, female, same data, C. W. Sabrosky collection.

This is apparently a Mexican species that extends into our range, but it can not be identified, from the description, with any known Mexican species.

The **hoodiana** group

This is a group of black species, similar in superficial appearance to the species referred to *Labostigmina*, but quite different structurally. The head, in both sexes, is wholly black or at most marked with yellow; the thorax, including the humeri and all but the apex of the scutellum, is black; the abdomen is much broader than the thorax and black in ground color, marked with linear or triangular maculations at the outer apices of the segments, these maculations only occasionally extending basally. The ratio of the first and second segments varies from 3 :2 to 1 :1 ; the third segment is often long and slender; the fourth annulus is tapering, the fifth and sixth forming the style, which curves forward (except in *colei*); the fifth annulus is short, sometimes obscure. The media is two-branched, the third branch sometimes suggested by a stump.

O. argentata Fabr. and *O. microleon* Linn., from Europe, unquestionably belong to this group; *O. tigrina* Fabr., another European species, probably belongs here also. Apparently, this is the only American group that is also represented in the Old World.

Odontomyia hoodiana Bigot, 1887

Female: Head wholly black, the front moderately wide; front, face, and occiput covered with a yellow or golden pile; pile decidedly longest on the cheeks. Antennae black; ratio of first and second segments 3 : 2. Face prominent below antennae. Thorax and scutellum clothed with moderately dense, erect yellow pile, and, dorsally, with golden tomentum; pile rather uniform, longest on the pleura. Scutellum black, the narrow apices between the spines yellow; spines yellow, tipped with black. Markings of abdominal segments two, three, and four linear, extending to middle third of abdomen; segment five with definite lateral and posterior margins; vestiture, a yellow pile which is somewhat shorter than that of the thorax, and a more depressed black pile. Venter pale, unicolorous. Femora, except apices, coxae, and trochanters black; legs otherwise yellow, the tibiae sometimes more or less black; tarsi somewhat darkened. Wings hyaline, the strong veins yellow; R_4 wanting.

Male: Differs from the female as follows: Eyes briefly contiguous; the front, below the ocellar triangle, clothed with black pile, the frontal triangle with yellow pile. The abdominal markings somewhat broader than in the female, one-third to two-fifths the length of the segment; they are, however, rectangular, rather than triangular.

Type. Hood River, Ore.; Bigot collection.

Distribution: normally, British Columbia to California and Colorado; rare farther east, but recorded from Michigan and Minnesota. Minn.: Warroad, May 21; Mich.: Agricultural College, May 21, 1900. Kans.: Douglas Co., May 6, 1925 (R. H. Beamer); Ottawa Co., April 30, 1933 (D. A. Wilbur). Manitoba: Aweme, May 19, 1927 (N. Criddle). Colo.: Common in foothills (May) and mountains (June). N. M.: Santa Fe, June 26 (R. H. Painter). Mont.: Missoula, May 19, 1904. Idaho: Moscow Mt., June 23 (Frank Cole). Utah: Aspen Grove, env. Timpanogas (V. M. Tanner). B. C.: Cranbrook, May 15, 1920 (C. Garrett). Wash.: Walla Walla, April 25, 1930 (M. C. Lane). Ore.: Common. Calif.: Common, June in northern Calif., July in the mountains of southern California.

This is apparently the earliest spring species in many parts of its range. It feeds on Dandelion blossoms at Boulder, Colo., in May.

Odontomyia painteri, new species

Similar to *O. hoodiana*, but blacker; differs as follows:

Female: Pilosity of head and thorax shorter and less bushy, and white or silvery; there may be some yellow tomentum on the thorax. Mid-frontal suture bordered with yellow; as a rule, there is a yellow spot on each side of the ocellar triangle; in one paratopotype, the head is entirely black. Pile of abdomen silvery, much longer than in *O. hoodiana*, and almost wholly obscuring the more appressed black pile. Abdomen silvery in certain lights. Abdomen almost wholly black dorsally, the pale markings obscured. Length, 8–10 mm.

Male: Pilosity as in the female, that of the dorsum somewhat longer. Abdominal markings linear, similar to those of the female of *O. hoodiana*, but narrower.

Holotype, female, Sand Dunes, Medora, Kansas, April 17, 1932 (R. H. Painter); Painter collection. Allotype, male, same data. Paratopotypes, 33 females, 14 males, sand dunes, Medora, Kansas, April 13 and 17, 1932, (Painter, C.W. Sabrosky, H. M. Smith).

Paratypes, female, Ellsworth Co., Kansas, April 21, 1930; 1 male, 1 female, Stafford Co., Kansas, salt marshes, April 30 (Painter); 5 males, 3 females, Douglas Co., Kansas, April and May, 1923 (R. H. Beamer); 1 male, 1 female, Douglas Co., Kansas, April 29, 1933 (W. J. Brown); 1 female, Douglas Co., Kansas, April 17, 1924 (Beamer); 1 female, 1 male, Douglas Co., Kansas, April 17 and 25, 1923 (W. J. Brown). Paratypes in the collection of R. H. Painter, C. W. Sabrosky, Kansas State College, Colorado State College, the University of Kansas, the American Museum of Natural History, and elsewhere.

Odontomyia pubescens Day, 1882

Female: Head black, except for yellowish markings along the mid-frontal suture and a yellow spot to each side of the ocellar triangle.

Antennae black, the ratio of the first and second segments three to two. The vestiture of the head consists of whitish semi-appressed pile, which is longest on the cheeks; this pile is somewhat sparser and less shaggy than in *O. hoodiana*. Face moderately prominent. Thorax black; pile dense, white or yellow, strongly appressed on the dorsum, less so on the sterna, only moderately so on the pleura. Scutellum black, the apical fourth and the lateral margins yellow; spines linear; pile as on dorsum. Abdominal markings linear or rectangular, sometimes expanded basally; that of the second segment may reach the base of the segment laterally. Pile chiefly white or pale yellow. Venter yellow, its pile yellow. Length, 6.5 to 9 mm.

Male: Differs from the female as follows: Pile of the head and body somewhat longer, especially on the dorsum of the thorax where there is considerable erect pile in addition to the appressed tomentum. Abdominal markings triangular or subtriangular; laterally, they vary from half to almost the entire width of the segment.

Types, male and female, Calif.; in the Snow Entomological Collection.[1]

Distribution: Coast to coast, in the north. Numerous records from Que., N. S., Ont., Me., N. H., Conn., Mass., N. Y., N. J., Mich., Ind., Manitoba, Wis., Alta., S. D., Neb., Kansas, Idaho, Wyo., Colo., Utah, and B. C.; recorded from Arizona by Johnson (1895) and from California by Day (1882). A spring species, occurring in April and May; records from the mountains of Colorado run into July, while altitudinal records reach 8,300 feet at Walden, Colo. (Frank Lutz). Adults frequent willow blossoms at Boulder, Colo., in June.

Odontomyia interrupta Oliv., 1811

O. intermedia Wiedemann 1830, (syn. Johnson).

Closely allied to *O. pubescens;* it differs as follows: Coxae, trochanters, and femora, except apices, black. Abdominal markings linear in both sexes, though they may extend forward along the lateral margin in the female, as in *O. pubescens*. The appressed tomentum of the dorsum of the thorax tends to be a deeper yellow, sometimes approaching golden in color. Black pile of abdomen more prominent.

Type, "Carolina."

Distribution: More eastern and southern than the above, though strongly overlapping in range; there are intermediate forms, and the species may hybridize. Que.: Common. Ont.: Common. Man.: Common. Alta.: Edmonton, May 8, 1915 (F. S. Carr). Me.: Common. N. H.: Common. Mass.: Common. Conn.: Common. N. Y.: Ithaca, May 28. N. J.: Common. N. C.: Aberdeen, April 14, 1922 (Brimley), and April 17, 1923 (R. W. Leiby). Fla.: Jacksonville (recorded by Johnson). Miss.: Agricultural College, March 18 to April 9. Mich.:

[1]Two females in the Snow Collection, from Kern Co., Calif., are labelled "Type," and are included in Day's type series; they are, however, the females of *O. pilosa* Day.

Agricultural College. Minn.: Common. Wis.: Common. Ohio: Columbus, April 21, 1902. Kansas: Douglas Co., April. Nebr.: Cedar Bluffs, April. March to April in the south; April to June in the north.

Odontomyia pilosa Day, 1882

O. pyrrhostoma Bigot 1887.

A very distinct species, differing from all other species of Odontomyia that I know in its broad head.

Female: Head, from the dorsal aspect, noticeably wider than the thorax, the occiput horizontally concave; from the front, the head is at least twice as wide as high; the front is fully twice as wide as the diameter of the eyes. Face prominent below the base of the antennae, the maximum prominence being just above the oral margin. Head black, the lower occipital orbits and the oral margin broadly yellow; head clothed with a whitish to yellowish pile which is longest and densest on the cheeks. Antennae black; the first segment slightly longer than the second. Thorax black, its pile similar to that on the head, longest on the upper pleura, very short on the sternum; the dorsum and scutellum yellow-tomentose. Scutellum black, its very narrow apex, between the spines, yellow. Abdomen broader than the thorax, wholly pale-pilose, the pile longer laterally than on the disc, and longest at the base laterally; segments two to four with paired apical wedge-shaped markings laterally which extend about to the median half of the abdomen; the lateral margins of the segments briefly yellow anterior to these markings. Venter yellow. Coxae, trochanters, and femora reddish brown to black, except for the very narrow apices and bases of each segment, which are yellow; tibiae yellow, each with a reddish brown annulus near the center; hind tibiae reddish brown apically. Tarsi yellow, the tarsomeres darkened apically. Halteres yellow. Wings hyaline, the strong veins reddish brown; vein R_4 distinctly present; vein M_3 represented by a small stump. Length, 11-12 mm.

Male: Differs from the female as follows: The eyes are larger, the occipital orbits being consequently not nearly so wide; the eyes are not quite contiguous, their separation at the nearest point, however, being less than the diameter of the basal antennal segments. Head equal in width to the thorax. Yellow apex of the scutellum extending somewhat outside of the spines; the extent of the yellow region is apparently variable. The pale abdominal markings are somewhat broader than in the female. In one specimen, the apical half of the fore tibia is black.

Type, Calif.; in the Snow Entomological Collection of the University of Kansas.

Distribution: Ore. (recorded by Bigot). Calif.: Kern Co. (Daecke); Palm Springs, March 19 (C. H. Hicks); Stanford U., April (J. Thompson); Santa Rosa; Sunol, May 15 (Frank Cole). Ariz.: San Carlos, Gila River Valley (D. K. Duncan).

Odontomyia colei, new species

Male: Head black, no wider than the thorax; eyes contiguous; face moderately prominent, carinate; antennae wholly black, much shorter

than the other members of this group (except *pilosa*); first and second segments subequal; style thickened, not well differentiated; fifth annulus short. Pile of vertex and front largely black, that of face pale. Thorax black, rather uniformly clothed with dense pale pile; this is erect on the dorsum, as elsewhere. Scutellum black, very narrowly yellow at the extreme apex, the yellow extending, however, outside the spines; spines yellow, tipped with black. Abdomen black; second to fourth segments with triangular pale markings at the outer apical angles; these markings extend inward to the median half or third of the segments along their apices and anteriorly almost or quite to the bases; segment five with only a small semi-circular basal black spot. Venter pale. Coxae and femora black, briefly yellow apically and basally; tibiae yellow with a median black annulus; tarsi yellow, darkened apically. Wings hyaline, somewhat brownish in the marginal, first submarginal, and basal cells; veins heavy, brown; M_4 present. Length, 10 mm.

Female: Similar to the male; differs as follows: The front is marked with yellow along the mid-frontal suture, this line extending from the ocellar triangle to the base of the antennae; there is also a yellow spot to each side of the ocellar triangle, contiguous with the eye. Oral margin yellow or black. Pile of head and thorax largely appressed; a little erect pile on the dorsum of the thorax. Abdominal bands linear, very narrow.

Holotype, male, Panoche Creek, Calif., April 30, 1922 (A. J. Basinger); Frank Cole Collection. Allotype, female. Kern Co., Calif. (Snow Collection). Paratypes, male, female, Kern Co., Calif.

Nearest to *O. pilosa* Day; the much narrower head will readily distinguish the species. The females of this series were found in the Cotype series of *O. pubescens* Day; the paratype male was included in the cotype series of *O. pilosa* Day. The Kern Co. records in these type series must, therefore, be discredited.

Odontomyia nigerrima Loew, 1872

A very black species with a very thick, but distinctly differentiated, antennal style.

Female: Head black, strongly flattened from the dorso-ventral aspect; eyes bulging and prominent; front moderately wide, opaque; the mid-frontal suture becoming so prominent near the antennae that it may almost be considered a groove. Face prominent, shining black; the antennae situated at the apex of the prominence. First antennal segment subconical, the apex being nearest the head; second cylindrical; first and second subequal in length, clothed with short bristly hairs that slant forward; style thicker than in any other nearctic species, and blunt apically. Proboscis short; labella thick, brown. Pile of head grayish; that on genae much longer than elsewhere; that on occipital orbits thick and appressed, silvery. Thorax black, the dorsum clothed with dense gray appressed tomentum and somewhat less dense short pile; the vestiture of the pleura and pectus similar, but less dense. Scutellum black with a very narrow apex that encroaches but slightly upon the disc and runs but slightly beyond the spines; vestiture as on the dorsum.

Spines yellow. Abdomen black, with sparse white pile; segments two, three, and four marked on the posterior angles with yellow triangles which are at least half as high as the width of the segment but which extend along the apex of the segments only a short distance from the lateral margins, so that these triangles are definitely higher than broad. Venter pale. Legs entirely yellow; the coxae may be darkened. Vein R_4 wanting. Strong veins heavy; the membrane strongly clouded with brown in the region of the strong veins, particularly near the veins; the apex of the wing beyond the discal cell, however, is clear. Length, 8 mm.

Male: Similar to the female. The pile of the entire body is considerably longer, particularly on the head and dorsum of the thorax; that of the front is black, otherwise gray; the scutellum is black except for the very narrow apex and the spines; the femora, except the apices, and the coxae are black; the abdomen is practically all black, the pale markings being at most suggested at the incisures.

Type, "Middle States" Museum of Comparative Zoology, Cambridge, Mass.

Distribution: Ontario: Jordan, June 6, 1919 (W. A. Ross); Pt. Pelee, June 12, 1925 (Walley); Ottawa, June 3, 1914 (J. I. Beaulne). N. H.: Franconia (recorded by Johnson).

The **virgo** group

In this group, the head and thorax are black in ground color, in both sexes, at most marked with yellow or red (in one species, *O. hydroleonoides*, the red is extensive on the head of the female); the abdomen is yellow or green with a median black band which is broader in the female than in the male, and which may be almost the width of the abdomen. The radio-median cross-vein is erect; the medio-cubital cross-vein with about a 45° slant basad; the two cross-veins are about equal in length. Vein R_4 normally wanting. The basal two-thirds of the stem of the media is very weak; vein M_1 is weak, usually represented by a stump and a fold in the membrane; vein M_2 is reduced to a stump or wanting.

Odontomyia virgo Wiedemann, 1830

O. paron Walker 1849; *O. plebia* Loew 1872; *O. nigra* Day 1882 (syn. Johnson); *Odontomyina virgo* Enderlein 1930.

There is considerable variation in this species, and perhaps some of the above synonymy is not valid. To clear up the status of this species, or of specimens referred to it, it will perhaps be necessary to rear and study the immature forms of eastern specimens.

Female: Head black, clothed with whitish to yellowish appressed pile; face receding, with a slight median carina. First and second antennal segments subequal, the first slightly longer, yellow in color; the third segment variable in color from yellow to a black that contrasts sharply with the basal segments; style of third segment short, blunt. Thorax and scutellum black, clothed with moderately dense, short, whitish to yellowish appressed tomentum, densest dorsally; spines of scutellum yellow. Abdomen yellow in ground color, marked with black;

the black markings are quite variable, but in general consist of a continuous mid-dorsal band which is composed of a series of trapezoidal markings on the second to fourth segments, broadest basally; the median half of the first segment and a large more or less variable basal spot on the fifth are also black; in some specimens, the abdomen is largely black. Venter yellow. Pile of abdomen yellow; some black pile on the black regions. Legs yellow, the coxae somewhat darkened basally. Wings hyaline; vein R_4 wanting; the stronger veins yellow. Length, 6.5–8 mm.

Male: Differs from the female as follows: The eyes are subcontiguous; the occipital orbits wanting; the pile on the face is more erect; the thorax with considerable erect or semi-erect pile, but with little tomentum. The abdominal markings are similar, but on an average much narrower.

Type, Savannah, Ga.

Distribution: Common in the northern half of the United States, coast to coast; I have numerous records from Me., N. H., Vt., Mass., Conn., N. Y., N. J., Ohio, Mich., Ind., Ill., Wis., Minn., S. D., Nebr., Kansas, and Colo.; also from Quebec, Ont., and Manitoba. Utah: Logan (Titus) and Farr West (Tanner). Ore.: numerous records. Va.: Quantico (C. D. Duncan). Recorded from N. C., Ga., and Texas, by Johnson. June and July; I have one record in August (Michigan).

The most common variations involve the coloration of the head, which may be variously marked with yellow. Most commmoly this yellow appears along the lower occular orbits and the inner margins of the cheeks; the latter may be entirely yellow. Rarely the vertex is marked with a small yellow spot on each side of the ocellar triangle. The antennae may be wholly yellow. There is some variation in the width of the cheeks; they are usually narrower than the upper occipital orbits, though they may be rather conspicuously wider. The oral margin may be yellow. As a rule, the black band of the abdomen occupies slightly less than the median half in the male and about the median two-thirds in the female; however, the female may, on the one hand, approach the male in markings, or it may, on the other, have the abdomen chiefly black, with narrow lateral margins and small, rounded yellow spots on the second segment.

The bluntness of the antennal style is the most constant character for distinguishing this species from *O. hydroleonoides*, *O. pilimana*, and *O. borealis*.

Odontomyia hydroleonoides Johnson, 1895

Female: Head black in ground color, but in actuality extensively marked with reddish yellow; the entire front and vertex, except for the ocellar triangle, are of this color; from the vertex two yellowish wedge-shaped marks extend down upon the occiput; the face is black, with the reddish yellow encroaching more or less on each side along the inner occular orbits and down the middle below the base of the antennae; the extent of the yellow coloration is variable. The oral margin and cheeks may be slightly reddish. Face receding below the antennae, slightly

carinate. Antennae red; segments one and two subequal; fourth to sixth annuli of the third segment black; style acute, curved. Thorax and scutellum black; scutellum yellow apically, this color extending laterally and basally somewhat beyond the spines; spines yellow; thorax and scutellum densely pale-yellow tomentose. Abdomen green, marked with a median black stripe which runs in somewhat at the posterior margins of the segments, except sometimes the first; the stripe terminates in a semi-circular marking on the fifth segment. Venter green. Legs uniformly yellow, the coxae darkened basally. Length, 8-9 mm.

Male: Head wholly black. Entire thorax, particularly the dorsum, clothed with considerable erect pile in addition to the tomentum. Otherwise as in the female.

Type, Museum of Comparative Zoology, Harvard. Recorded by Johnson from Canada, Michigan, Illinois, and Utah.

Distribution: Ontario: Prince Edward Co. (Evans), Toronto, and Pt. Stanley. N. J.: Newfoundland, July 11, 1918 (Nicolay). N. Y.: (recorded by Leonard, 1928). Mich.: Johnson. Ill.: Johnson. Wis.: Madison, Door Co., and Ripon (C. L. Fluke). Minn.: Numerous records. Kansas: Numerous specimens from Atchison, Leavenworth, and Marion Co. (R. H. Beamer and E. P. Breakey). Colo.: Boulder (James). Ore.: Hood River. Late June to early August.

This species is not as near to the European *O. hydroleon* Linn. as Johnson supposed, though it does bear a strong superficial resemblance to that species.

Odontomyia pilimana Loew, 1866

Female: Head entirely black, except for a small oval spot on each side of the mid-frontal suture, just below the ocellar triangle; the entire head clothed with a whitish appressed pile which is shortest and densest on the occipital orbits and longest and most nearly erect on the front and cheeks. Face distinctly tuberculate below the base of the antennae. Antennae wholly yellow, or at most with the three apical annuli of the third segment darkened; first and second segments subequal; the two apical annuli of the third segment forming a distinct, curved, acute style. Thorax black, strongly white-tomentose; some semi-erect pile below the wing bases. Humeri yellow. Scutellum black, whitish tomentose; the spines yellow, moderately prominent; the very apex of the scutellum, between the spines, yellow. Abdomen greenish yellow, marked medially with an irregular black stripe which is usually not more than one-fifth the width of the abdomen on segments one, two, and three, but which widens to half the width of the abdomen on segment four; typically, this band consists of a triangular spot with its base near the apex of the first segment and its apex at the apex of the second, and connected more or less broadly with a similar spot on the third segment, which in turn connects with a large subquadrate spot on the fourth and a semi-circular spot, its diameter basad, on the fifth. Venter wholly green. Pile of abdomen yellow. Legs yellow, the coxae somewhat darkened. Wings hyaline; veins yellow. Length, 10-11 mm.

Male: Head wholly black; dorsum of thorax with very short, erect, dense pile in addition to the tomentum; black abdominal band narrower than in the female. Otherwise as in the female.

Type, Illinois; in the Museum of Comparative Zoology, Cambridge, Mass.

Distribution: Common in the west central states; apparently replaced by the related *O. borealis* farther east. Ill.: type. Wis.: Madison (Fluke), Mendoka Lake (S. Chandler), and Ft. Atkinson (Burrill). Minn.: Numerous records throughout the state. Iowa: Numerous records. Va.: 1 male. Manitoba: Douglas (R. D. Bird). Kansas: Numerous records, as far west as Scott Co. S. D.: White (Severin), Custer, and Waubay. Colo.: Sterling Reservoir (Grace Sandhouse); Owens Lake, near Boulder (Charles Hicks). Idaho: Parma (E. C. Fisk). July and August; June in Kansas and Virginia.

There is some variation in the form of the abdominal band; it may broaden on the third as well as on the fourth segment. The pile on the basitarsi and the tuberculate face will distinguish the species.

Odontomyia borealis, new species

Closely related to *O. pilimana*, but the face is flat or at most only slightly carinate, and the oral margin is reddish brown as a rule, while in a large series of *pilimana* the face is in all cases strongly tuberculate, the tubercle being as high as the length of the first antennal segment, and the oral margin is uniformly black. In *borealis*, the pile and tomentum of the thoracic dorsum is yellowish, rather than whitish, and in the male the erect pile is considerably longer than in *pilimana*. Otherwise, the two species seem to agree in all respects.

Holotype, female, Ottawa, Canada, July 9, 1913 (J. I. Beaulne); in the American Museum of Natural History. Allotype, male, same data.

Paratypes: female, Ramsey Co., Minn., June 9, 1922 (A. A. Nichol); 4 females, Madison, Wis., July 2–18 (C. L. Fluke); 1 female, Green Bay, Wis., July 11, 1925 (A. Granovsky); 1 male, Ft. Atkinson, Wis., July 9, 1913 (A. C. Burrill); 3 males, Madison, Wis., July 20, 1917, and July 15 and 19, 1929 (Fluke); 1 male, Gray's Mill, Wis. July 3, 1930 (C. L. Fluke); 1 female, Ottawa, Canada; 1 female, Ottawa, Canada. July 11, 1913 (Beaulne); 1 female, Queen's Park, Aylmer, Quebec., July 23, 1926 (C. B. Hutchings); 1 female, Jordan, Ontario, July 16, 1929 (Curran); 1 male, Urbana, Ill.; 1 male, Hastings, B'burn Co., Ontario, July 22, 1902 (Evans); 1 male, Ottawa (James Fletcher); 1 male, Belleville, Ontario; 1 male, Pottawotomie Co., Kansas, June 24, 1933 (Painter); 1 female, Guelph. Ontario, July 10, 1913 (Curran); 1 female, "136 Ind. Greene 23–25–6–01;" 1 male, 1 female, Hamburg, Michigan, July 6, 1930; 1 female,

Michigan, 1932. Paratypes in the Canadian National Museum, University of Wisconsin and University of Minnesota Collections, and in the Collections of R. H. Painter, Frank Cole, G. Steyskal, and the writer.

Odontomyia aldrichi Johnson, 1895

Closely related to *O. pilimana* Loew; it differs as follows: The face is not at all or only slightly tuberculate; the pile and tomentum of the thorax is slightly more yellowish; and the abdomen is entirely green or yellow, except for a small trapezoidal marking on the first segment. The anterior basitarsi are long-pilose below, as in *pilimana*. Length, 7.5–9 mm.

Type, Riley Co., Kansas; in the Museum of Comparative Zoology, Cambridge, Mass.

Distribution: I have numerous records from eastern and central Kansas. Johnson records it from Sand Hills and West Point, Nebr. It is apparently abundant locally, but of narrow range—perhaps primarily a sand hills species. June and July.

The close relationship of this species to *O. pilimana* has apparently been overlooked.

Odontomyia americana Day, 1882

I have seen only the two type specimens; the following description is based on them.

Male: Face black; oral margin pale. Antennae wholly yellow; structurally as in *O. pilimana*. Thorax wholly black; the pile whitish, yellow laterally. Scutellum black; the very narrow apices and the spines yellow. Abdomen yellow, marked with a black longitudinal band that occupies the median half; this band is of about equal width on segments two, three, and four, somewhat broader on segment one, and terminating on the basal half of segment five; the yellow ground color runs in slightly at the incisures. This band is approximately straight on the lateral margins. Venter pale. Legs wholly pale; the hair on the under side of the anterior basitarsi no longer than on the middle and hind basitarsi. Vein R_4 wanting.

Types, 2 males, Calif. (Baron); in the Snow Entomological Collection, Lawrence, Kansas.

The short pile of the anterior basitarsi and the antennal structure link this species to *hydroleonoides;* the pale oral margin and the nature of the abdominal band in *americana* will separate the two species.

The **arcuata** group

A characteristic group of the Western States. The head is yellow in ground color in the female, yellow or black in the male; the thorax is marked with yellow at least on the post-alar calli and for a brief distance before the calli; the humeri are usually yellow, and, in the female, at least, the pleura are extensively yellow. Abdominal markings extremely

variable, but probably derived from a type with large median basal markings on the segments; in the more typical species, the abdomen is yellow, with *transverse* bands on the basal half, though these may extend onto the apical half of the segments to such an extent that the abdomen is largely black; these markings are often modified to form a longitudinal median stripe, especially in the males. At any rate, the ground color is yellow, even though black may predominate. The first antennal segment is no longer than the second; the fifth annulus of the third segment is much shorter than the fourth and sixth, and is often inconspicuous. Vein R_4 is normally present; the first two branches of the media run almost to the wing margin, though they are usually weak and M_1 may disappear for a short distance near its base; M_3 is represented by a stump.

Odontomyia microstoma Loew, 1865

Female: Head yellow; ocellar triangle shining black, with a poorly defined brown spot which gradually merges into yellow on the vertex, to each side of it; a pair of elliptical brown spots, also poorly defined, on the front just above the base of the antennae and extending from the inner occular orbits almost to the mid-frontal suture. Pile of head wholly pale, longest and most plentiful on the face. Face gently receding below the antennae. Proboscis black. Style of third antennal segment very prominent, long and slender; the apical annullus fully as long as the first antennal segment, the preapical annulus quite distinct. Color of antennae variable, yellow to pale brown; the apices of the first and second segments often paler than their bases. Thorax subequal in width to the head, pale tomentose, with a small amount of erect pile, most abundant on the propleura and sternum; dorsum black; pleura and sternum pale, the sternum with two black spots that are poorly defined and sometimes fused. Scutellum yellow; spines blunt, brownish apically; the scutellum slightly darkened basally; tomentum and pile pale; more erect pile than on the dorsum. Abdomen black or brown dorsally, with broad pale margins; the black poorly defined, and usually merging gradually into the yellow of the margins; its pile chiefly black. Venter yellow, sometimes partly darkened into brown. Legs yellow, the tarsi somewhat darkened apically. Wings hyaline; heavy veins yellow to brown; vein R_4 present; M_1 and M_2 heavier than in most members of the group; M_3 represented by a stump. Length, 8–12 mm., usually 9–10 mm.

Male: Differs from the female as follows: Eyes subcontiguous; face, (except the lower occular orbits), occipital orbits, and occiput black or dark brown; lower occular orbits and cheeks yellow. Pleura and sternum black, almost concolorous with the dorsum. Femora brownish yellow, somewhat darker than in the female.

Types, "Mass. and N. Y."; in the Museum of Comparative Zoology, Cambridge, Mass.

Distribution: Upper Atlantic seaboard, near the sea. Common along the coast of Me., N. H., Mass., R. I., Conn., N. Y., and N. J.; recorded by Johnson from Md.

This species is unique among the species of *Odontomyia* known to me because of the very long antennal style, which Johnson compares to that of *Clitellaria* (*Euclitellaria*); but, aside from the elongation of the two annuli making up the style, the antennae are quite similar to those of the other members of the *arcuata* group. Aside from the indefiniteness of the markings of the abdomen, this species is quite similar to the more typical members of the group. I can not see any pile on the eyes of the specimens I have examined except under the compound microscope; it is quite possible, however, that there may be variation in this respect inasmuch as Curran (1927) in his key placed this species with those having pilose eyes.

Odontomyia hirtocculata, new name

Odontomyia pacifica Curran 1927, nec Meigen.[2]

I quote Curran's description of *pacifica*.

"Related to *arcuata* Loew but the eyes are strongly pilose in both sexes. Black, with yellow markings. Length, 10 to 12 mm.

"Female: Head pale yellow, the front and upper orbits with rusty tinge; a broad, almost complete black band across the ocelli expanded a little behind the ocelli and a second somewhat broader band at lower third of the front, with three short upward projections toward the middle and corresponding emarginations below; face with a small subtriangular black spot in the upper slopes of the depressions. Front wider than eye, rather strongly widening below, the face very wide. Pile wholly cinerous white, shining, fairly long. Palpi yellow, strongly swollen apically. Proboscis black; labellae short and broad. Antennae blackish, the basal segment reddish, a little longer than the second, both with pale hair. Hair of eyes cinerous.

"Mesonotum black; humeri yellow; posterior calli and very broad border of the scutellum, rusty yellow; hair appressed, silvery, the whole of the thorax with erect pale cinerous pile but it is sparse on the dorsum except laterally. Pleura rusty yellowish, with a broad projection upward on the mesopleura, pectus and metanotum black.

"Legs rusty reddish, the apical three or four tarsal segments brown or blackish although the apical segment of the anterior four tarsi may be reddish. Posterior tibiae with brownish stain on apical two fifths.

"Wings hyaline; veins luteous; third vein branched; third posterior vein only weakly indicated at the base. Squamae white. Halteres pale yellowish.

"Abdomen black above, the narrow lateral margin yellow; first segment with posterior margin narrowly yellow, the second and third with the broad posterior border narrowing towards the sides where they form small triangles and strongly narrowed in the middle, the narrow posterior border of the fourth segment and apical half of the fifth, rusty yellowish. Venter wholly pale rusty reddish. Hair on black portions abundant, very short, appressed, black, elsewhere pale.

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[2] *O. pacifica* Meigen is given by Verrall, 1909, as a synonym of the European *O. limbata* Meigen.

"Male: Very broad sides of face, all the face below the depressions, the cheeks and posterior orbits on the lower half, very pale yellowish. Humeri black; posterior calli brownish, scutellum as in female; pleura black with a large spot above the front coxae, upper narrow border of mesopleura and a median vitta behind the wings rusty yellowish. Pile wholly erect, cinereous. The abdominal fasciae are all interrupted, are somewhat more longitudinally triangular laterally and are conspicuously broadened inwardly; the band on the fourth segment is wholly narrow; apical fourth of the fifth segment yellow.

"*Holotype*, ♀, Stanford University, Calif., Sept.; No. 2359 in the Canadian National Collection, Ottawa. *Allotype*, ♂, same data."

The hairy eyes distinguish this species from the other nearctic species. Mr. Curran has asked me to rename it, as *pacifica* is preoccupied. I have not seen this species; but Dr. Curran's description indicates unquestionably that it belongs where he places it, with *O. arcuata* Loew.

Odontomyia arcuata Loew, 1872

O. arcuata Johnson 1895 (partim); *O. arcuata* Curran 1927.

This species has frequently been misidentified. Johnson confused it with several related species. I have seen some specimens determined by him as *arcuata* which are really *inaequalis* Loew, *tumida* Banks, and *alticola* James. I have seen no specimens of the true *arcuata* from east of the Rockies.

O. arcuata itself is extremely variable; so it is difficult to draw up a description which will fit even a majority of specimens. Perhaps subspecies may be recognized after sufficient material has been examined. This species may be recognized by the characters given in the key and by Bank's notes on the type (in Curran 1927), which are diagnostic. I quote Banks remarks:

"*O. arcuata* is practically unique in our collection; 1 type. The others that were put with it are all smaller and look different. The first and second pale bands on the abdomen are plainly interrupted; spines of scutellum black at tip; face without median or lateral marks below, those above very broad, the vertex practically entirely black, only two minute pale spots behind. The hair on the thorax is plainly yellowish and dense, seen from above the hair from base of wings forward sticks out very prominently, is dense and almost brownish. O. S. California specimens have vertex much more pale, the hair on thorax less dense, seen from above no dense hair from base of wings forward, pale bands on abdomen complete."

The black on the vertex of the female varies from a narrow transverse band just below the ocellar triangle to a region involving practically all the vertex and extending onto the front. The abdomen, in both sexes, is, typically, marked with transverse bands that occupy the basal half of the segments; these are often connected medially with the bands of the adjoining segments. In some cases, the pale markings are limited to rather broad lateral margins that extend somewhat inward at

the incisures; or, the abdomen may be almost all black. On the other hand, the black bands may be interrupted medially in the males, so that the black markings consist of a mid-dorsal stripe, with the original bands only suggested by the presence of disconnected lateral spots on the basal half of the segments.

Type, female; Museum of Comparative Zoology, Cambridge, Mass.

Distribution: Utah: Corrine, July 13 to Aug. 5, 1929 (Knowlton and Bowen). Oregon: North Powder (J. Nottingham); Baker (Scullen); Lake Co. (Scullen); Silver Lake (Scullen); July 13 to Aug. 10. Calif.: Redlands, Sept. 26, 1913 (Cole); La Quinta (Cole). Ariz.: San Bernardino Ranch, Conchise Co., Aug. (Snow).

Odontomyia flava Day, 1882

The following diagnosis is based on the type, which is badly eaten by Anthreni, but which shows all the essential characters, except that the genitalia are missing.

Male: Antennae obscurely yellow; face black, the oral margin yellow. Dorsum of thorax black; the posterior calli and a small region above the base of each wing, yellow. Scutellum black, except for the very narrow apex; spines yellow. Pile yellow. Abdomen as in *arcuata:* that is, with a series of transverse bands on the basal half of the segments which connect broadly in the middle; or it may be described as a mid-dorsal band which widens out broadly on the basal half of the segments; the abdominal bands are, however, broader and not so strongly arcuate as in *arcuata.*

Type, Wyoming; in the Snow Entomological Collection, Lawrence, Kansas.

Distribution: I know this species only from the type.

Odontomyia idahoensis James, 1932b

I quote my description of the type:

"Male: Face and ocellar triangle black; oral margin and a spot to each side of it yellow. Proboscis black; base brownish yellow; palpi yellow. First two segments of the antennae black; third missing in the type, probably black. Eyes reddish brown. Occiput velvety black. Thorax wholly black; pile yellow, moderately dense, erect on dorsum, somewhat appressed on the pectus. Scutellum black, lateral and apical margins yellow; spines short, thick, sharp, black. First, fourth, and fifth segments of abdomen largely black, the fourth with lateral margins, widest posteriorly, the fifth with somewhat obscure lateral and evident posterior margins; second and third segments largely yellow, each with a black vertebra-shaped marking which connects with the adjoining segments to form a continuous median line and extends laterally to within a short distance of the lateral margin, the approach being greatest anteriorly. Venter yellow; legs wholly reddish-yellow, the tarsi darkened. Wings hyaline; veins yellow; third vein branched. The

posterior cell emits three veins, the third one rather indistinct. Length, 12 mm.; width of abdomen, 4.5 mm.; length of abdomen, 5.5 mm.

"*Holotype*, ♂, Bear Lake, Idaho, altitude 6,200 ft.; July 9, 1920."

Distribution: Idaho: Type. Oregon: "P" Ranch, Harney Co., June 25, 1922 (Chamberlin).

Odontomyia confusa, new species

Close to *inaequalis* Loew and *arcuata* Loew; the females might have passed for a variation of the latter, if it were not for the males which were taken at the same time and place and which are unquestionably cospecific. The relationship is closer to *inaequalis* than to *arcuata*.

Female: Head marked with black as follows: Vertex with a black band extending laterally from each side of the ocellar triangle to the inner occular orbits; front, above the base of the antennae, with two spots which are typically crescent-shaped but which may, however, fuse with the vertical markings, thus making the front and vertex largely black. Face with a median black stripe which widens laterally to each side, in the form of an inverted Y, above the facial depression. The face may or may not be marked with additional brownish splotches. Proboscis black; occiput black, the orbits broadly yellow. Face somewhat more prominent below the antennae than in *arcuata*. Dorsum of thorax black except humeri, posterior calli, and supra-alar regions, which are yellow; the dorsum clothed with dense pale yellow tomentum. Pleura yellow; pectus black. Scutellum black on basal, yellow on apical, half; spines yellow. Abdomen yellow in ground color, though in actuality largely black, the black markings consisting of transverse bands which are connected medially with those of adjacent segments and which occupy the large part of the segments, the yellow background being confined to the narrow lateral and anterior margins of the segments. In the Mexican specimen, the anterior margins are complete. Legs yellow, the tarsi somewhat darkened; the femora may be partly brown or reddish brown. Length, 10 mm.

Male: Face black; oral margins and sometimes the facial depression pale. Thorax black; pleura marked with yellow below the wing bases and above the front coxae, the latter markings sometimes extending almost to the dorso-pleural suture; humeri pale, posterior angles black. Scutellum black, the rather broad apical and lateral margins yellow; spines yellow, tipped with black. Abdominal black band almost the width of the segments; the abdomen may be described as black, with a narrow yellow lateral margin, though the ground color is really yellow; the apical fourth of the fifth segment and the genitalia yellow. Femora variably yellowish to brownish. Otherwise, except sexually, as in the female.

Holotype, female, Alamosa, Colo., Aug. 28, 1932 (Sam McCampbell). Colorado State College Collection. Allotype, male, Alamosa, Colo., July 20, 1932 (McCampbell).

Paratypes, 2 females, same data as allotype; male, North Powder, Ore., July 13, 1931 (J. Nottingham); male, Sumner Lake, Lake Co., Ore., July 28, 1930 (H. A. Scullen), on *Chrysothamnus;* female, Cuautla, Mor., Mexico (W. L. Tower). Paratypes in the Snow Entomological Collection, the American Museum of Natural History, and the collections of Joseph Wilcox and of the writer.

Odontomyia inaequalis Loew, 1865

Odontomyia arcuata Johnson 1895 (partim).

A variable species, close to *arcuata* and *confusa*. The female is similar to *arcuata*, but has a mid-facial line that broadens out in the form of an inverted T just above the facial depression; the transverse bar of the T is about half the width of the face; this marking sometimes assumes the form of a triangle, the apex of which is directed upward. The markings on the vertex consist of a transverse black band extending from eye to eye and including the vertical triangle; the front is marked with a wavy black band usually interrupted medially. The antennae are variable; usually segments one and two are yellow, and three black. Dorsum of thorax black; humeri, posterior angles, and supra-alar regions yellow; pleura largely yellow; sternum black. Scutellum yellow, black basally. Abdominal bands usually confined to the basal half of the segments, not arcuate along the apical margin, and never connected. Legs yellow. Length, 10 mm.

Male: Face black; oral margin yellow. Thorax black; pleura variably marked with yellow; at least a yellow spot below the wing bases and another one, in the form of a band, extending from the front coxae to the dorso-pleural suture. Humeri and posterior angles usually black. Abdominal band usually occupying the median third of the abdomen; similar to that of *O. alticola* (q. v.). Otherwise, except sexually, as in the female.

Type, female; in the Museum of Comparative Zoology, Cambridge, Mass.

Distribution: Great Lakes region to Idaho, Utah, California, and Texas. "Hudson Bay Terr."—type. Manitoba: (recorded by Curran, 1927). Ill.: Chicago, June 27, 1899 (W. M. Wheeler). Minn.: Big Stone Co. (Oestlund); Brown Valley, Travers Co., gravelly hills, Aug. 7, 1932 (E. R. Tickham). S. D.: Common, late July and August. Nebr.: Lincoln, Sept. 18, 1923 (R. W. Dawson). Kansas: Stafford Co., salt marshes, Aug. 1, 1934 (C. W. Sabrosky); Coolidge, July 31, 1933 (Rodeck and James). Texas: Galveston, May (F. H. Snow); Coyote Lake, Bailey Co., Aug. 15, 1921 (C. D. Duncan). Idaho: Starkey, July 23, 1926 (F. E. Whitehead). Wyo.: (Fluke). Colo.: Common, late June to August, plains and low foothills; Boulder, Fort Collins, Ft. Lupton, Sterling (Grace Sandhouse), Huerfano Co. (R. H. Painter), Roggen, Wray. N. M.: Albuquerque, Aug. 15. Utah: Common: Corrine, Lamport, Grantsville, Spanish Forks, Blue Creek, Hyde Park (all Knowlton), August. Ariz.: San Bernardino R., Aug. (Snow).

Odontomyia alticola James, 1932a

Female: Head yellow; a black band across the vertex, including the vertical triangle and extending almost to the eyes; a wavy black band in the middle of the front, usually interrupted twice medially. Oral margin at most slightly brownish; usually wholly yellow. Head clothed with rather sparse white or yellow pile and tomentum. First two segments of antennae yellow; the third black, sometimes somewhat yellowish basally. Dorsum of thorax black; humeri, posterior angles and supra-alar regions yellow; sometimes a little yellow in front of the suture. Pleura yellow; at most a brownish spot on the mesopleura; mesosternum and metasternum black, prosternum yellow. Scutellum yellow, at most with a few black hairs basally. Legs yellow; tarsi darkened apically. Abdomen yellow, marked with transverse bands as shown in Fig. 8. Thorax clothed with yellow appressed pile, moderately abdunant dorsally; abdomen with appressed yellow pile on the yellow, black pile on the black, regions. Length, 10 mm.

Male: Face yellow, the frontal triangle black; yellow of thoracic dorsum less extensive on supra-alar regions, not extending to the suture; scutellum narrowly black basally; prosternum at least marked with black; black of mesosternum extending onto the pleura and including the spot that is brown in the female. Abdomen marked with a median black stripe which begins on the first segment and consists of trapezoidal median spots on the second, third, and fourth segments, usually widest on the fourth; these spots are connected with each other and with a more or less irregularly defined spot on the basal half of the fifth. Otherwise as in the female, except sexually.

Type, Fort Collins, Colo; in the United States National Museum.

Distribution: South Dakota to New Mexico, California, and Oregon. S. D.: Hot Springs, July 9, 1924. Colo.: Common: Sterling, Ft. Collins, Boulder, Valmont, Canon City, Clifton, Delta, Princeton Hot Springs (Cockerell); late June and July. N. M.: Therma, Aug. 12 (A. B. Klots); Chavez, July 8 (P. A. Readio); Roosevelt Co., July 7 (R. H. Beamer). Idaho: Boise, July and August (C. Wakeland). Utah: Provo (Wickham); Farr West (Tanner); Logan, June 27 (Knowlton) and June 11, 1906. Ariz.: Oak Cr. Canon, 600 ft., Aug. (Snow). Ore.: Ontario, 2,150 ft., Aug. 2, 1921 (Scullen); Le Grande, July 9, 1922 (Chamberlin). Calif.: Gavalon Hills, nr. Riverside, June 12, 1934 (C. M. Dammers); Pine Valley, June (James).

Odontomyia occidentalis, new species

Perhaps closest to *O. alticola*. If the three specimens before me are cospecific, as they seem to be, the species is quite a variable one. The following description is of the holotype:

Female: Head yellow; vertex with a broad black band, reaching from eye to eye and including the ocellar triangle; front with a wavy, more or less M-shaped band, reaching from eye to eye, and not interrupted. First and second antennal segments yellow; third brownish.

Thorax black dorsally; humeri, post-alar callosities and supra-alar regions yellow; the yellow of the latter extend about half way from the post-alar callosities to the suture. Pleura yellow, a brownish spot on the mesopleura; pectus from the anterior legs posteriorly black. Scutellum yellow, narrowly black basally; lateral spines darkened, apical spines yellow. Pile of thorax wholly pale, rather dense and appressed on the dorsum. Black abdominal markings as in *alticola*, but more extensive, the bands of each segment connecting with those of the adjacent segments; pile of the black regions black, otherwise pale. Legs yellow, somewhat darkened beyond the basitarsi. Length, 10 mm.

The paratype female differs in having the face splotched with brown, and in the abdominal markings, which are less extensively black. These are apparently too variable to make a detailed description of much value; but, at any rate, the abdominal markings, like *alticola*, are narrower laterally than medially and rounded at the posterior corners, and, unlike *alticola*, are connected medially with those of the adjacent segments.

Male: Face yellow; frontal triangle and facial depression black; thorax with shaggy white pile, especially dorsally; thorax wholly black dorsally; pleura and sternum as in the female. Black of scutellum more extensive; spines black at the tip. Abdominal band similar to that of female. Otherwise, except sexually, as in the female.

Holotype, female, Camp Roosevelt, Yellowstone National Park, July 14–17, 1923. In the writer's collection. Allotype, male, Madison River, Yellowstone Park (D. Eldon Beck). Paratype, female, Lakeview, Ore., July 27, 1930, 4,800 ft. (H. A. Scullen).

Odontomyia tumida Banks, 1926

The profile of the face distinguishes this species, in both sexes, from its relatives.

Female: Head yellow; a black band across the vertex, from eye to eye, and including the ocellar triangle; two black spots on the front, contiguous with the eyes. Face very wide; in lateral view, it projects forward the width of the eye; in frontal view, it is almost twice as wide, above the oral margin, as the vertex; the face is much wider, therefore as compared with the vertex, than in the other members of this group. First antennal segment pale; antennae otherwise black. Dorsum of thorax black, except humeri, posterior calli, and supra-alar regions, which are yellow; pleura yellow; pectus black; the pile of the black regions silvery, appressed; that of the pale regions yellow and more erect. Scutellum yellow. Abdomen yellow; segments two to five with black transverse bands which are usually confined to the basal half and never contiguous with the lateral margins nor with the bands of the adjacent segments; those on segments two and three strongly biarcuate on the posterior margins; that on four less so; that on five semi-elliptical. Short, black pile on the black regions; pile otherwise yellow. Venter yellow. Legs yellow; tarsi darkened apically. Length, 8–10 mm.

Male: As in the female, the face is broader than in related species; cf. Figs. 5 and 6. Pile of thorax longer and more shaggy, that of the dorsum not appressed. The black of the pectus extends onto the mesopleura. Less yellow on the supra-alar regions. Scutellum narrowly black basally. Abdomen similar to female, but the bands are wider, and at least those of segments two, three, and four are narrowly connected medially; segment one wholly black.

Type, female, California; Museum of Comparative Zoology, Cambridge, Mass.

Distribution: Kans.: Doniphan Co., July 23, 1924 (E. P. Breakey). Colo.: Common; White Rocks (Boulder Co.); Brighton; Ft. Collins; Trinidad; Alamosa; Roggen; Aug. and Sept. Utah: Common: Ogden, Bountiful, Provo, Parowan (Tanner), Elberta, Corrine, Brigham, Promontory, Amalga, Blue Creek, Cache Jct., Mt. Pleasant, Ephraim; Aug. and Sept. Nevada: Tuscatora, Sept. 9, 1923. N. M.: Roosevelt Co., Belen Co., and Socorro Co., August (R. H. Beamer). Ore.: Keno and Merill Co. (A. L. Lovett); Klamath Agency (Scullen); Hereford, 3,660 ft. (Scullen); August. Calif.: Riverside, Sept. and Oct. (Timberlake).

Odontomyia cincta Olivier, 1811

O. extremis Day 1882.

Female: Head yellow; vertex with a black band that includes the ocellar triangle and reaches toward, but does not attain, the eyes; front with a pair of black spots contiguous with the eyes. Antennae yellow. Pile of head sparse, yellow. Dorsum of thorax black; a broad, well-defined lateral stripe on each side reaching from the humeri to the post-alar callus. Pleura yellow; a somewhat darker spot on the mesopleura; prosternum yellow; meso- and metasterna black. Thorax with considerable short yellow erect pile; the black regions of the dorsum, in addition, with considerable appressed golden pile, that of the sternum with appressed yellow or white pile. Scutellum yellow, pale-pilose. Abdomen yellow; segments 2–5 with black bands which definitely attain the lateral margins of the segments; these bands are narrow laterally, but broaden out to almost the length of the segment medially, except on segment five, where the maximum width is half the length of the segment. Segment one with an apical median spot confluent with the spot on segment two. Venter yellow. Legs yellow, the last four tarsomeres brown. Length, 10–11 mm.

Male: Like the female, except sexually; the vertical and frontal triangles are black, the head otherwise yellow or green; the pile of the thorax is longer, with considerable erect pile of the dorsum; the scutellum is very narrowly black basally. Some black on the prosternum and mesopleura. The abdominal bands are broadly connected medially; segment one is wholly black except for a small lateral spot to each side; the band on segment two is confined to the median two-thirds of the segment; those on the following segments may or may not extend to the margins, or may be interrupted, with only a black spot on each margin.

Type, "Carolina."

Distribution: A species of wide distribution, common in the east. Ont.: Jordan and Pt. Pelee (Curran, Walley). Me., N. H., Vt., Mass., R. I., and Conn. (Johnson, 1925). N. Y.: Flatbush (J. L. Zabriskie); Syracuse (Basinger); Astoria, L. I. Pa.: Hartstown Bg. (J. N. Knull). N. J.: Newfoundland, (A. Nicolay). Fla.: recorded by Johnson, 1913. Ohio: Cedar Point (V. R. Haber). Mich.: Ag. College (C. P. Gillette). Minn.: Common throughout the state. Wis.: Common throughout the state. Mo.: Atherton, May. Ind.: No additional data. S. D.: Brookings (M. Fredricksen); Springfield. Texas: Donna, May 13, 1933 (Monk); Brownsville, Feb. 23, 1915 (Timberlake). Ore.: Blitzen River, July 6, 1906. Utah: Riverdale, June (C. Lynn Hayward, C. J. D. Brown). Calif.: Santa Rosa, May 6. May and June in the northeast. This is the only *Odontomyia* of which I have records from the four corners of the United States, though it seems to be rare except in the north east.

Odontomyia discolorata, new species

Female: Head yellow; a black band on the vertex including the ocellar triangle and a short space to each side of it, but not reaching the eyes; a pair of black spots on the front and another to each side of the antennae, each contiguous with the eyes; more or less brown on the oral margin and in the facial depression. Occipital orbits narrower than usual in this group. Pile of head pale, coarse, rather abundant; some short black pile on the vertex. Antennae yellow; third segment sometimes brownish. Thorax black; sides of dorsum yellow, this yellow region poorly defined, however; it extends from each humerus to the corresponding post-alar callus, and includes these regions. Sternum black; pleura yellow, the black of the sternum extending broadly onto the mesopleura. Pile white, moderately dense, appressed. Scutellum yellow, white-pilose, broadly black-pilose basally. Abdomen yellow or green, with a narrow black stripe dorsally; in the holotype, it is no wider basally than the distance between the scutellar spines; it becomes three times this width on the fourth segment and ends on the fifth. Pile yellow, semi-appressed; the dorsum, in addition, with considerable black appressed pile medially. Legs green to yellow; tarsi darkened apically. R_4 present. Length, 11 mm.

Male: Head black; thorax black, except humeri and a rather indistinct spot above the front coxae, which are yellow; pile shaggier and longer on head and thorax, that of the dorsum erect; abdominal stripe much broader than in the female, broadening to about half the width of the fourth segment. Otherwise, except sexually, as in the female.

Holotype, female, Donna, Texas, July 30, 1933 (J. W. Monk); in the writer's collection. Allotype, male, Donna. Texas, July 1, 1933 (Monk). Paratype, female, Donna, Texas, July 28, 1933 (Monk).

This species approaches the typical *O. hydroleon* Linn. the most closely of any of our species, and may belong in the group with that species, rather than in the *arcuata* group. The two groups are, at the most, closely related, and, perhaps, should not be separated.

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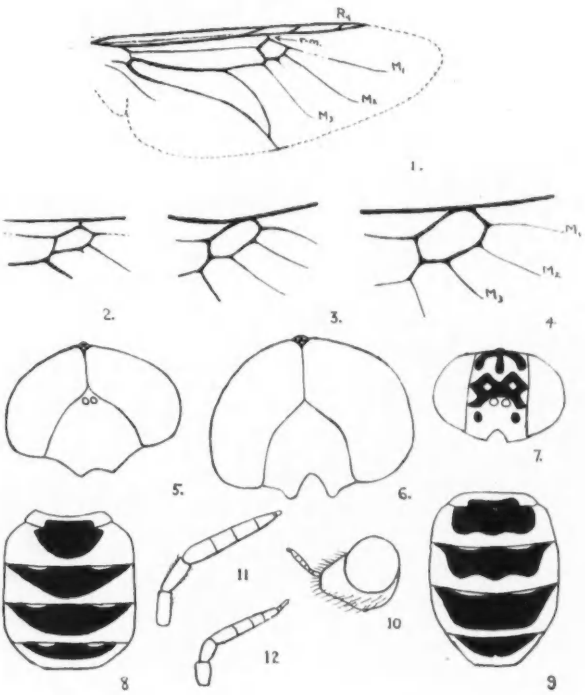


EXPLANATION OF PLATE

Fig. 1. *Odontomyia alticola* James: wing.
Fig. 2. *Odontomyia virgo* Wied.: discal cell of wing.
Fig. 3. *Odontomyia trivittata* Say: discal cell of wing.
Fig. 4. *Odontomyia truquii* Bellardi: discal cell of wing.
Fig. 5. *Odontomyia tumida* Banks: head, face view (male).
Fig. 6. *Odontomyia arcuata* Loew: head, face view (male).
Fig. 7. *Odontomyia vertebrata* Say: head, face view (female).
Fig. 8. *Odontomyia alticola* James: abdomen (female).
Fig. 9. *Odontomyia tumida* Banks: abdomen (female).
Fig. 10. *Odontomyia nigerrima* Loew: head, side view (male).
Fig. 11. *Odontomyia truquii* Bellardi: antenna.
Fig. 12. *Odontomyia cincta* Olivier: antenna.

BOOK NOTICES

THE PIONEER CENTURY OF AMERICAN ENTOMOLOGY, by HARRY B. WEISS. 320 pages, mimeograph, linen bound. Published by the author, 19 N. 7th Ave., New Brunswick, New Jersey. Price, $4.25 postpaid.

If we believe the author's preface, the writing of this interesting volume was unavoidable as he had reached that age when the mind looks backward. Perhaps because we do not dare look backward we have had unusual pleasure in seeing the past of American entomology through more courageous eyes.

Professor Weiss has that collector's instinct which appears to lead the possessor unerringly to historic records otherwise lost or hidden to the routine investigator. With a genius for collecting this type of data he has given entomologists as detailed an account as is possible at present of the beginnings of American entomology up to about 1865.

The material is arranged under the following chapter headings:

I. Entomology in the Accounts of Early Travelers (1588–1723); II. Entomology of Early Books and Papers (1731–1800); III. Early Years of the Nineteenth Century (1800–1817); IV. Thomas Say and His Contemporaries (1817–1831); V. From Zimmermann to LeConte (1832–1845); VI. Asa Fitch and Other Entomologists (1845–1854); VII. The Glover and Osten-Sacken Period (1855–1860); VIII. From Walsh to Cowan (1860–1865); IX. Entomology in Agricultural Periodicals Before 1865; X. Scientific Societies, Journals, etc.; XI. Some Notes on Canada; and XII. Entomology in Europe During the Pioneer Century in America.

The volume is of especial value as it brings together all known published mentions of insects in the colonial literature and builds up a picture of the gradual unfolding of scientific interest in American entomology. Through its pages we follow the development of the science. This review is carried up to 1865 at about which time agricultural interests compelled the investment of government and other funds in the study of insect pests. From then on work was no longer "Pioneer." Entomology was on a financial basis.

Besides the author's "Preface" the work carries, page 313, an interesting "Postface," the first of such we remember having seen. It is a brief statement, almost tearful, of the difficulties encountered in finding a publisher. We question the statement therein that "entomologists are not extensive purchasers of books." The reviewer's wife would not agree with him. Our conscience pricks us a little less often if we keep the catalogues of dealers in entomological literature locked up in our office.

While written with no subheads the volume is very well indexed so that particular items are easily located. The volume is a thorough and sound addition to the history of American entomology. We regret to observe that the edition of this valuable work has been limited to 150 copies.—C. H. K.

LES INSECTES NUISIBLES AUX PLANTES CULTIVEES, LEURS MOEURS, LEUR DESTRUCTION, by A. BALACHOWSKY AND L. MESNIL. Preface by PAUL MARCHAL. Roy. Quarto, Vol. I, Part I, pages i-xvi and 1-592; Part II, pages 593-1135. Vol. II, pages i-xi and 1136-1921. 1369 text figs., 8 colored plates. For sale by M. L. Mery, Editeur, 17 Rue Victor-Masse, Paris 9e, France. Price (paper bound) 200 fr. plus 45 fr. postage. (*Circa* $15.00.)

This latest European work on applied entomology is the most impressive work covering a broad field in the science that has appeared since the publication of the two large volumes of "Gli Insetti" by Berlese. Doctor Balachowsky is Professor on the Faculty of the National School of Agriculture, Grignon, and is Director of the Laboratory at the Central Station of Entomology, Paris. Doctor Mesnil is Chief of Projects at the Central Station of Entomology and Inspector in the Plant Quarantine Service. Thus in this magnificent work we have the authoritative experience of leaders in the field of applied entomology.

Other than a graceful preface by the Dean of French entomology, Professor Paul Marchal, and the usual Author's preface, the work is strictly applied ento-

mology throughout. There is no introductory matter on morphology or taxonomy. The word of thanks in the Authors' preface indicates extensive correspondence with European entomologists concerning the problems involved.

With Chapter I the work plunges at once into a ten-page account of the peach-tree buprestid, *Capnodis tenebrionis*, under the general chapter heading, "Insects Injurious to Cultivated Fruit Trees." The chapter then, under eight subheads, deals with the various pests of fruit trees in continental Europe, Palestine and Northern Africa, with more casual mentions of related problems in more distant regions. The timing of control measures is usually given as precisely as possible for the region of Paris. Thus the work is essentially for France, secondarily for the Mediterranean region and in general for Europe at large.

A list of chapter headings will indicate the arrangement and contents: Chapter I. Insects Injurious to Cultivated Fruit Trees; II. Insects Injurious to the Grape; III. Insects Injurious to Grains and Pasture Grasses; IV. Insects Injurious to Vegetables and Commercial Plants; V. Insects Injurious to Ornamental Plants and Flowers; VI. Polyphagous Insects Injurious to All Crops; VII. Insects Injurious to Stored Grains and Their Products; VIII. Insecticides; Bibliography; Index.

The many minor pests are usually each given a paragraph or two under the insect's name. The major pests are usually treated under three subheads—Characters, Life-history (Biology) and Treatment.

In the latter the experience embodied in European work on the various pests is largely drawn upon, particularly French experience in dealing with the problems. References out to these authors are given parenthetically while numerous foot notes refer the reader to literature of more distant regions or less to the immediate point.

The two volumes give us a picture of the present status of Continental applied entomology. Cultural methods are prominent as are insecticides, but no major space has been given to biological control though many of the curious life histories of parasitoids and such have been worked out by European entomologists. This lesser interest can be accounted for partly by the fact that Euro-Asia is the area of greatest advancement in insect evolution and that probably more native pests are already under a greater biological control than are such in the western world or the southern hemisphere. For this reason also, the necessities of control have not been so imperative and the applied science has lagged somewhat as compared to its development in America and colonial lands.

We like the large type of illustration used throughout the work. These have about one-third the amount of reduction used in American entomological literature. They are easy to see. The numerous zinc etchings are well drawn and brilliant.

Altogether this is a particularly able presentation of the problems of applied entomology in Europe and reflects great honor on the distinguished authors.

—C. H. K.

FORMICIDAE UKRAINAE, by W. KARAWAJEW, pp. 163–316, 28 text figs. The second and final portion of the work, published as a volume (unnumbered) in the Series, "Travaux systematique et faunistique" of the Ukrainian Academy of Sciences, 1936, Kiev, Ukrainia.

This volume is the second and final part of the work of the same title which was given a "Notice" in the ANNALS, Volume XXVIII, p. 409, 1935. That part of 162 pages covered structure and habits of ants and the Ukrainian species of the subfamilies Ponerinae and Myrmecinae. The work is completed in the present volume where the subfamilies Dolichoderinae and Formicinae are treated. These subfamilies contain thirty-eight forms (species, subspecies and varieties). In an appendix are added nine forms to the list of Myrmecinae published in the first volume (1934). This is a total of eighty-six forms of ants known from Ukrainia.

This part of the work follows exactly the format of the previous part. The keys and general text are in Russian. The technical descriptions are in German. Each species is illustrated with one or more figures in line drawing. Pages 280–310 (Russian) are devoted to a brief review of the geological history of ants, the physical relations of the ants to their environment and the significance of ants in the biological environment. Following these parts is a list of the author's works on ants and a table of contents.

The author of this notice just this week completed a ten weeks study of the specific and varietal characters of the twenty-five or so forms of Formica and Camponotus found in Ohio. Our dream of a clear definition of ant species on characters of the male genitalia has faded. Poor characters, illy defined, of this type occur in the males of Formica but all males of Camponotus appear to have genitalia that differ only in size. This is said to be true in other genera. Yet by habits, ecological distribution, etc., we come to an easy recognition of many forms of ants that differ structurally from each other only in the presence or absence of a few extra hairs on some portion of the body, slight differences in surface texture under magnification, etc. Beyond this is fragmentary evidence of what might be termed physiological species, forms apparently identical structurally but which have different nest habits, distribution, etc. The rich behavior of ants may be subject to its own evolution into such physiological species. This is the next or virgin area of study in the field of myrmecology. What is a species in the Formicidae? This condition of affairs makes all students of the group hesitate when the taxonomists suggest that they drop the very awkward quadrinomials and even quinquenomials so freely used in naming ant forms. These fantastic names are the courteous attempts of the men, who know ants by habits in the field, to build such structurally vague forms into a morphological taxonomy acceptable to taxonomists in museums of dead and pinned forms. Apparently we are gradually being forced to a recognition of physiological species which may in the distant future even involve a change in the rules of nomenclature.

But to return to our knitting: We shall close this ramble with a word of appreciation of Karawajew and all those men who have had the physical strength and determination to carry them through a life-time of study in this difficult area. The taxonomy of Odonata, the only other field with which we have some familiarity, is very simple compared with that of the Formicidae.—C. H. K.

"INSECTAE BORINQUENSES," A REVISED ANNOTATED CHECK-LIST OF THE INSECTS OF PUERTO RICO, by GEORGE W. WOLCOTT, with a HOST-PLANT INDEX, by JOSE I. OTERO. Published as Volume XX, No. 1, of The Journal of Agriculture of the University of Puerto Rico, pages 1–627, 309 text figures. Published by The Agricultural Experiment Station, Rio Piedras, Puerto Rico.

This is a revision of "Insectae Portoricensis" (Jour. Dept. Agr., Porto Rico, Vol. VII, No. 1, 1923). The additions to the list have necessitated an increase of over 300 pages beyond the size of that first edition. The introduction is an interesting history of early Puerto Rican entomology starting with a list of insects published in Paris in 1810. Pages 9–19 give a list of the more formal papers on Puerto Rican entomology. Pages 20–574 comprise the main body of the work, while pages 575–627 are occupied by the index to insects and that to plant hosts.

It is a volume of use to students of neotropical and particularly of West Indian entomology. Until the year 1925 work on the insects of this island had been desultory. Then the Federal Horticultural Board began inspection of all fruit and vegetables shipped to the United States. This necessitated definite records of possible economic species. It forced the development of applied entomology within the island. Finally the New York Academy of Sciences sponsored a "Scientific Survey of Porto Rico and the Virgin Islands" under which auspices and otherwise were published monographic papers on several groups. All of these findings are summarized in the present volume.—C. H. K.

FOREST INSECTS, by R. W. DOANE, E. C. VAN DYKE, W. J. CHAMBERLIN, and H. E. BURKE. Pages i-ix and 1-463. McGraw-Hill Book Co., Inc., New York. Price, $4.50.

The authors believe that a text and reference book on this rapidly developing subject can be presented in the most straightforward manner by discussing the various forest insects in their natural groups. Obviously, only one or two of the most important insects in each group can be treated at length, the others receiving but short comment. This type of organization eliminates much needless repetition and also gives the reader a broad viewpoint not found in other texts of a similar nature.

The book has particular advantages in that it presents the pooled resources of four authorities each contributing from his specialty. One point of criticism might be made in that conditions found in the western part of the United States appear to receive more consideration than those of other forest areas.

In the first four chapters the importance of forest entomology and various types of control measures are stressed. Nearly 200 pages in the next three chapters are devoted to the Scolytoidea, Buprestidae, Elateridae, Ptinoidea, Anobiidae, Bostrichidae, Lyctidae, Scarabaeidae, Chrysomelidae, weevils, and other beetles of less importance. Moths and butterflies, Hymenoptera, aphids and scale insects and miscellaneous insects are discussed in separate chapters. Chapter Twelve considers the termite problem from such angles as nature of work, prevention and remedial measures and classification.

An appendix in which the important coniferous and hardwood trees and some of their principal insect enemies are listed is particularly useful. The index is very complete and lists both common and scientific names. Very few of the 234 line-drawings and photographs of insect stages and damage have been borrowed. These illustrations appear to have been carefully prepared.—B. J. L.

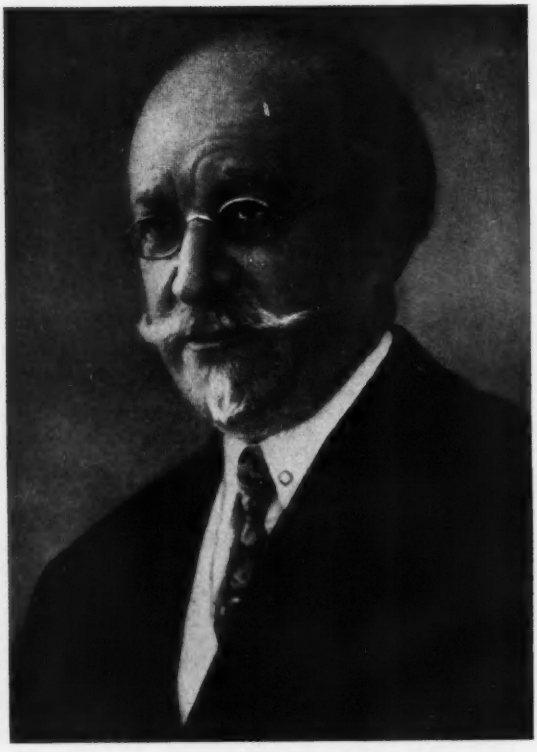
ADDRESSES OF THE RETIRING PRESIDENTS OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS. Compiled by LEE A. STRONG; mimeographed and issued June 19, 1936, through the Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture, Washington, D. C. The first of a series consisting of 333 pages.

Mr. Strong, President of the American Association of Economic Entomologists in 1935, has assembled the first twenty-two addresses given by the retiring presidents of the Association at the annual meetings from 1890 to 1911, inclusive. The remaining addresses will be mimeographed from time to time.

These addresses represent a wealth of valuable entomological material and much credit is due Mr. Strong for making them available to entomologists throughout the country.

The series opens with the report of the First Annual Meeting held in Washington, D. C., November 12, 1889. The first address was given by C. V. Riley, in 1890, and, with the exception of that for the year 1906, all have been preserved.

The addresses given by C. V. Riley, James Fletcher, J. A. Lintner, S. A. Forbes, John B. Smith, A. L. Quaintance, H. Garman and H. A. Morgan summarize the progress made in the control of current insect pests. L. O. Howard and C. H. Fernald each dwelt on the history of Economic Entomology. F. L. Washburn, F. M. Webster, Herbert Osborn, S. A. Forbes and W. E. Britton were concerned with the duties, training and place of entomologists in agriculture. C. L. Marlatt discussed the danger of introduced pests. C. P. Gillette and E. D. Sanderson spoke of the objects and work of the Association. Miscellaneous addresses were: "Life History Studies on the Codling Moth," by C. P. Gillette; "Insect Photography," by M. V. Slingerland; "The Study of Forest Entomology in America," by A. D. Hopkins; and "The Literature of American Economic Entomology," by E. P. Felt.—B. J. L.



Patrick Semeon Diarshasky